

**Technical Support Document for  
SE 416<sup>TH</sup> STREET OVERLAY:  
SHINGLES IN PAVING DEMONSTRATION**

**KING COUNTY, WASHINGTON  
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**Technical Support Document for**  
**SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration**

**King County Materials Laboratory**

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**EXECUTIVE SUMMARY**

This document provides technical support for evaluating the use of post-consumer recycled asphalt shingles (RAS) as a component of Hot Mix Asphalt (HMA) for paving projects under the jurisdiction of the King County Department of Transportation (KCDOT). The Road Services Division of the KCDOT, in partnership with the Solid Waste Division of the King County Department of Natural Resources and Parks, and the Washington State Department of Transportation (WSDOT) Materials Laboratory conducted a pilot project to evaluate the use of post-consumer recycled asphalt shingles (RAS) in combination with recycled asphalt pavement (RAP) in Hot Mix Asphalt (HMA).

The King County Materials Laboratory (KCML) specifically assisted in selecting the pilot project roadway section, documented the pre-construction condition of the selected roadway, provided limited preliminary testing of the materials used, conducted quality control testing during construction, and coordinated post-construction testing. This document presents a summary of our work and participation in support of this project.

It has been a common practice to use RAP in HMA for many years on King County Roadways. Currently, up to 20 percent of the total weight of aggregate in the mix can consist of RAP. Incorporating post-consumer RAS in HMA on public roadways, however, is a relatively new concept in Washington State. Over the past several years various State and local municipalities across the country have allowed the use of RAS (tear-off shingles and manufacturers scrap) in roadway applications through provisional and permissive materials specifications. This demonstration project provides the first documented use of RAS on a public roadway within Washington State.

The potential to commonly use RAS in HMA mixes provides two major advantages. First, RAS contains a substantial amount of asphalt binder that could be substituted for a portion of the virgin asphalt binder. Secondly, recycling post-consumer shingles substantially reduces the amount of landfill waste.

To utilize RAS in pavements, deleterious materials such as nails and other extraneous products must first be removed. The RAS materials must then be tested to verify the product is substantially free of asbestos. In addition, the shingles need to be pulverized to a size that will ensure uniform mixing and to assist in the release of the RAS asphalt binder into the total mix.

An additional concern incorporating RAS is the type of asphalt binder in shingles. The asphalt binder used in roofing materials is typically stiffer than asphalt pavement binders. A

significantly stiffer asphalt binder may contribute to premature fatigue cracking of the roadway. Conversely, a stiffer asphalt binder may aid in reducing rutting over the long-term performance of the roadway.

Prior to construction, a preliminary mix design incorporating the proposed amount of RAS was conducted to verify the performance of the combined HMA mix. The demonstration project allowed for the use of 3 percent RAS and 15 percent RAP in the total HMA job mix for a combined total of 18 percent recycled materials. Preliminary HMA mix design testing was conducted by the WSDOT Materials Laboratory in Tumwater, Washington.

A two-mile section of roadway (SE 416<sup>th</sup> Street) located in south King County near the City of Enumclaw was selected for the pilot project. In September 2009 the roadway was overlaid with a 2-inch thick layer of HMA incorporating both RAP and RAS in designated Test Sections.

Initial observations and test results indicate that, when the virgin asphalt binder content is correctly adjusted, the addition of 3 percent RAS does not significantly impact the quality and placement of the HMA job mix. Further testing, analysis, and documentation of the roadway will continue for a minimum of three years to verify the long-term performance of the roadway.

## **1.0 INTRODUCTION**

### **1.1 BACKGROUND**

On August 21, 2007 the Solid Waste Division (SWD) of the King County Department of Natural Resources and Parks coordinated a meeting of potential stakeholders for the purpose of conducting a paving demonstration utilizing post-consumer recycled asphalt singles (RAS). Following the meeting, a paving demonstration advisory group was formed consisting of private contractors, consultants, and various public agency personnel to implement the project, including the Road Services Division (RSD) of the King County Department of Transportation.

In May of 2008, SWD secured an agreement with RSD to sponsor a paving project for the 2009 construction season. It was agreed, based on discussions with the paving demonstration advisory group and RSD, that the Hot Mix Asphalt (HMA) job mix would contain 3 percent RAS in the mix design. In addition, because typical asphalt roadways in King County can be constructed using up to 20 percent recycled asphalt pavement (RAP), 15 percent of the total mix would contain RAP.

### **1.2 ROADWAY SELECTION PROCESS**

The available roadways considered for this project were limited based on a number of criteria. First, because of budget restraints, the selection was limited to roadways that were to be included as part of King County's 2009 Overlay Contract. Secondly, in order to provide

enough tonnage of asphalt to increase contractor interest and for analysis purposes, the roadway was restricted to a pavement section with an approximate minimum length of 2 miles. Based on these initial requirements, 5 roadways were found to meet the above criteria.

To further refine the selection, RSD personnel with extensive experience in roadway design and construction observed the condition of each roadway and provided a weighted qualitative score on ten different selection criteria. SE 416<sup>th</sup> Street received the highest combined score and was chosen as the best available candidate for the demonstration project. The rating criteria used and summation of scoring totals are included in Appendix A.

### **1.3 GENERAL OVERVIEW OF THE SELECTED ROADWAY CANDIDATE**

SE 416<sup>th</sup> Street, within the project limits, is located in south King County, near the City of Enumclaw. The roadway runs east-west and serves as a 2-lane paved rural arterial with 2-foot wide paved shoulders. The project extended approximately 2 miles, beginning at the intersection of 212<sup>th</sup> Avenue SE (Station 10+20) and ending at 244<sup>th</sup> Avenue SE (Station 116+00). The general location is shown on the Vicinity Map, Figure 1, at the conclusion of the text.

The surface topography consists of gently rolling pastoral terrain overlaying glacial and lahar deposits of various soil types ranging from gravels to fine-grained silt. Beginning at 212<sup>th</sup> Avenue SE (Station 10+20) and travelling in an easterly direction, the roadway is relatively straight, level, and sited along an elevated area of the valley. At roughly one mile (Station 63+10) the road slowly descends to the valley floor and crosses over a short-span bridge at Newaukum Creek. From Newaukum Creek, the roadway gradually ascends over a hill near 236<sup>th</sup> Avenue SE (Station 89+10), and then returns to the valley floor and the end of the project at 244<sup>th</sup> Avenue SE (Station 116+00).

The project scope of work included planing bituminous surfaces, removal of raised pavement markers and other obstructions, and preleveling portions of the roadway as needed to construct final grade requirements. The entire roadway was then overlayed with a minimum 2-inch thick layer of HMA that, in designated sections, incorporated both RAP and RAS.

### **1.4 TEST SECTION LAYOUT**

Initial observations of the road surface and surrounding topography, based on a brief site reconnaissance, suggested that the western half of the 2-mile long roadway section (Station 10+20 to Station 63+10) was in fair condition, typically exhibiting low to moderate longitudinal cracking in the wheel paths at intermittent locations. The eastern half of the roadway (Station 63+10 to Station 116+00) appeared to be in fair to poor condition, exhibiting a higher degree of deterioration as compared to the western half of the roadway section.

To account for the variability in pavement and underlying soil conditions, the roadway was divided into 4 separate Test Sections, each approximately ½ mile in length. The division

allowed for one Test Section each of the RAP only and RAP/RAS HMA mix to be sited on both the western and eastern portion of the roadway. Each Test Section required about 1000 tons of HMA to provide for a 2-inch thick overlay. The Test Section Layout for this project is shown in Table 1.

<b>TABLE 1</b>				
<b>Se 416<sup>TH</sup> Street Overlay</b>				
<b>Test Section Layout</b>				
<b>Lane Description</b>	<b>Test Section #1</b>	<b>Test Section #2</b>	<b>Test Section #3</b>	<b>Test Section #4</b>
<b>Stationing</b>	10+20 to 36+50	36+50 to 63+10	63+10 to 89+66	89+66 to 116+00
<b>Lane 1 (eastbound)</b>	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP
<b>Lane 2 (westbound)</b>	HMA Mix with 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 3% RAS and 15% RAP	HMA Mix with 15% RAP

A graphical depiction of the Test Section Layout is shown in Figure 2, at the conclusion of the text section of this report.

## **2.0 PRE-CONSTRUCTION CONDITONS**

### **2.1 BACKGROUND**

In late May 2009, as part of the King County overlay program, and prior to the final selection of SE 416<sup>th</sup> Street as the roadway candidate for this project, King County Maintenance crews milled out selected 40-inch wide strips of the pavement surface approximately 2.5 inches in depth within distressed wheel path areas. The milled areas were then patched with HMA. Detailed pavement conditions prior to milling and patching were not documented. In general, distressed areas were concentrated in the driving lane wheel paths in the form of longitudinal cracking.

### **2.2 PAVEMENT CONDITION SURVEY METHODS**

Two separate pre-construction pavement condition surveys were conducted on the roadway prior to overlay operations. In the late spring/early summer of 2009, KCML conducted a walking survey using methodologies generally prescribed by ASTM D-6433-03 (ASTM) and the Northwest Pavement Management Association. In July 2009, WSDOT conducted a drive-through survey using laser and other sensing devices mounted to a distress data

collection van. Pavement distresses observed during the surveys were categorized and quantified for the purpose of developing a Pavement Condition Index (PCI) for the entire roadway and each Test Section.

Typically, pavement condition surveys are conducted as part of an agency-wide Pavement Management Program. The general intent of the survey is to provide a method of measuring and documenting the current condition of the pavement for comparison with future evaluations. These measurements assist in determining the rate of deterioration and consequently, needs for rehabilitation or repairs. Under many circumstances, the entire roadway is not surveyed for an agency-wide pavement management system. Instead, a percentage of the overall roadway is selected using random sampling principles in order to obtain a sufficient size and quantity of sample lots that statistically represent the overall roadway length.

Completion of the pavement condition survey will result in the generation of one or more PCI's. PCI is a numerical indicator that rates the present condition of the pavement based upon the type, quantity, and distress levels observed. A newly constructed pavement would have a PCI of 100 and a roadway that has failed would have a rating near 0. The PCI is also an indicator of the structural integrity and potential operational or safety issues associated with the pavement.

Pavement deterioration is a curvilinear relationship that accelerates or increases with time and exposure. The ASTM survey method includes up to 19 different categories of distress. This project utilized five distress categories including alligator cracking, longitudinal cracking, transverse cracking, rutting, and patching for flexible pavements. Each category of distress is qualitatively classified as having a Low, Medium, or High level of severity. An initial uncorrected deduct value is then determined for each distress category and severity level as a function of the distress density (percent of total area or length).

The final deduct value was determined based upon the total sum of initial deduct values and number of different distress categories within a sample lot or section of roadway. The total corrected deduct value is subtracted from 100 to determine the overall PCI. ASTM suggests the terminology shown in Table 2 to describe the condition of pavements based upon various PCI rating ranges.

<b>TABLE 2</b>	
<b>SE 416<sup>TH</sup> Street Overlay</b>	
<b>PCI Rating Ranges</b>	
<b>PCI Rating</b>	<b>Condition Description</b>
85 to 100	Excellent
70 to 85	Very Good
55 to 70	Good
40 to 55	Fair
25 to 40	Poor
10 to 25	Very Poor
0 to 10	Failed

### **2.2.1 Pavement Condition Survey (KCML)**

A pavement condition survey of the entire roadway, within the project limits, was conducted by KCML personnel prior to overlay of the roadway. The survey was conducted over a period of time from 6-29-09 through 8-4-09 during generally sunny to partly cloudy weather conditions. The survey was performed by walking the entire roadway and documenting pavement distress conditions generally following methodologies prescribed by ASTM D-6433 and the Northwest Pavement Management Association.

For this site specific survey, the entire length of roadway between fog lines was evaluated in 100-foot intervals, beginning at Station 10+20 and ending at Station 116+00. The lateral extent of distressed areas was measured using a wheeled-tape, with the distresses being noted separately for each traffic lane.

On the basis of the observed distresses, a PCI rating was developed for the entire road as well as for each Test Section. The ratings are summarized in Table 3.

<b>TABLE 3</b>	
<b>SE 416<sup>th</sup> Street Overlay</b>	
<b>KCML Pre-Construction Pavement Condition Indices (PCI)</b>	
Test Section 1	78.0
Test Section 2	72.0
Test Section 3	44.0
Test Section 4	70.0
Overall Rating	66.0

A detailed breakdown of distress quantities for each Test Section is presented in Appendix A. Plan view graphical representations depicting the categories and level of distress in 100-foot sections along the roadway alignment are also included in Appendix A.

### **2.2.2 Pavement Condition Survey (WSDOT)**

On 7-10-09, The WSDOT Materials Laboratory conducted a pavement condition survey utilizing laser equipment mounted to a distress data collection van. The van is also equipped to film the entire roadway surface during testing. WSDOT designates a Pavement Condition Index (PCI) as a Pavement Structural Condition (PSC), documenting the forms and severity levels of distress including alligator cracking, longitudinal cracking, transverse cracking, and patching for flexible pavements. In addition to PSC testing, the van is capable of documenting pavement rutting condition (PRC) and roughness based on the International Roughness Index (IRI). A brief definition of each rating system is presented below.

#### ***Pavement Structural Condition (PSC)***

The PSC is a scoring of the pavement structure based on a compilation of visible surface distresses. This score ranges from 100 being a new surface absent of any distress to 0

representing total pavement failure. The ratings are similar to those presented in Table 2 (PCI Rating Ranges).

For calculation of the PSC, laser images of the pavement surface are obtained utilizing the distress data collection van. The van is driven along the Test Section collecting images while travelling near the posted speed limit. These images are collected every 25.4 feet, scanning the entire width of the lane. The images are then evaluated with other pertinent roadway information, such as length and area. An operator then views the images in a frame by frame progression made possible by the vendor of the collection van, in this case Pathway Services out of Oklahoma. The operator, using the "WSDOT Pavement Surface Condition Rating Manual", records pavement distresses as they appear. Utilizing special hot keys on the keyboard, the operator marks the distress by type, severity, and extent as they show up on the images. The computer program then compiles all distresses and their associated deduct values to calculate the PSC.

### ***Pavement Rutting Condition (PRC)***

PRC is a score representing the extent of rutting present in the rated lane. This is accomplished by using a Laser Rut Measurement System (LRMS) mounted on the distress data collection van. Two of these collection devices are mounted on the back of the collection van, one for each half of the lane width. The devices collect laser images every 5 feet through the length of the site. Utilizing a special program developed by the vendor, INO out of Canada, the rut depths for each of the wheel paths are measured. The rating scale for the PRC ranges from 100 (no rutting) to 0 (deep rutting dependent on the length). Typically, a roadway would be considered for rehabilitation when the PRC rating is 50 or below.

### ***International Roughness Index (IRI)***

IRI is a measurement for roughness of the pavement surface. The collection van is outfitted with two accelerometers, one for each wheel path. As the van travels over the test site these accelerometers measure the movement of the van. For this rating, the scoring ranges from low to high and is measured in inches per mile. The higher the score, the rougher the roadway section, with zero considered equivalent to a smooth glass surface. WSDOT uses the following rankings, shown in Table 4, when rating the IRI:

<b>TABLE 4</b>	
<b>SE 416<sup>th</sup> Street Overlay</b>	
<b>IRI Roughness Scale</b>	
<b>IRI ( inches/mile)</b>	<b>Pavement Rating</b>
<b>Below 95</b>	<b>Very Good</b>
<b>95-170</b>	<b>Good</b>
<b>170-220</b>	<b>Fair</b>
<b>220-320</b>	<b>Poor</b>
<b>Above 320</b>	<b>Very Poor</b>

It should be noted that, for consistent readings, the van should be able to move through the

measured section unimpeded. Stop signs, lights, turning vehicles all affect the roughness readings since the van must slow down or brake then accelerate causing up and down motion of the van.

### **WSDOT Pavement Condition Summary**

Test results from the WSDOT pavement condition survey are summarized in Table 5.

<b>TABLE 5</b>			
<b>SE 416<sup>th</sup> Street Overlay</b>			
<b>WSDOT Pre-Construction Pavement Condition Survey</b>			
<b>Test Section</b>	<b>PSC</b>	<b>PRC</b>	<b>IRI</b>
Test Section 1	43.4	80.1	83
Test Section 2	24.8	76.9	94
Test Section 3	26.8	76.7	185
Test Section 4	29.8	79.4	132
Overall Rating	31.2	79.0	124

**Notes:** PSC = Pavement Structural Condition (WSDOT)  
 PRC = Pavement Rutting Condition (WSDOT)  
 IRI = International Roughness Index (inches/mile)

The recorded pavement condition of the roadway surface varied significantly when comparing data obtained from KCML and WSDOT. A comparison of the ratings is presented in Table 6.

<b>TABLE 6</b>		
<b>SE 416<sup>th</sup> Street Overlay</b>		
<b>Comparison of KCML and WSDOT Pavement Rating Conditions</b>		
<b>Test Section</b>	<b>KCML Ratings (PCI)</b>	<b>WSDOT Ratings (PSC)</b>
Test Section 1	78	43.4
Test Section 2	72	24.8
Test Section 3	44	26.8
Test Section 4	70	29.8
Overall Rating	66	31.2

The pavement condition rating system for both PCI and PSC is relatively equivalent. Both techniques rely substantially on qualitative methods for rating the road surface. The discrepancies found in the above recorded values are most likely due to subjective and qualitative interpretation for the rated severity of observed distressed areas. KCML interpreted the majority of longitudinal cracking as low severity, while WSDOT generally measured these distresses as moderately severe. In addition, KCML designated the majority of asphalt patching as low severity. WSDOT documented the patching as medium severity.

The pavement rutting condition survey indicated minimal rutting within the roadway. Rutting values were similar in all Test Sections. The roughness condition for Test Sections 1 and 2

rated very good. Test Sections 3 and 4 rated from good to fair, respectively.

## **2.3 PAVEMENT CORING**

On 8-5-09, a total of 16 asphalt concrete pavement (ACP) cores were obtained from the roadway within the project limits. Four cores were retrieved from each Test Section, two from each lane within the Test Section. The 4-inch diameter cores were measured to determine overall and individual layer thickness. At each core location the underlying surfacing material was excavated to expose the subgrade soils. A summarized description of the pavement thickness and underlying materials found in each Test Section is presented below:

- **Test Section 1 (Cores 1 through 4):** Average pavement thickness was approximately 4.5 inches in depth. On average, roughly 3 inches of crushed surfacing materials were found below the asphalt pavement. Silty gravel (GM) was found below the crushed surfacing layer.
- **Test Section 2 (Cores 5 through 8):** The pavement section was similar to Test Section 1, consisting of 4.5 inches of ACP overlaying 3 inches of crushed surfacing. Silty gravels were encountered below the crushed surfacing layer.
- **Test Section 3 (Cores 9 through 12):** The pavement section consisted of about 4.5 inches of ACP overlaying approximately 2.0 inches of Bituminous Surface Treatment (BST) consisting of densely compacted gravels bonded with a thin asphalt binder. Silty sand (SM) was encountered below the BST layer.
- **Test Section 4 (Cores 13 through 16):** The pavement section consisted of 5.5 inches of ACP overlaying about 2.0 inches of Asphalt Treated Base (ATB). Silty sands were typically found below the ATB layer.

Graphical logs of the asphalt cores and excavated underlying soils, and an associated Exploration Map are presented in Appendix B.

## **2.4 BORINGS**

Subsurface testing was conducted by KCML on 8-6-09. A total of six exploratory borings were drilled within the right-of way of the roadway. At least one borehole was sited in each Test Section to obtain information on subsurface soil conditions throughout the alignment. The borings were advanced to a maximum depth of 11.0 feet below ground level using a truck-mounted drill rig equipped with a twelve-inch diameter open flight auger.

The relative density of granular soils and consistency or stiffness of cohesive soils was estimated based on drilling effort and visual observations. Disturbed, but representative, samples were obtained at various depths and returned to KCML for testing, as needed. The boring logs and related laboratory test results are included in Appendix B. A general description of the soils encountered in each Test Section is as follow:

- **Test Section 1:** Medium dense becoming dense silty gravel (GM)

- **Test Section 2:** Medium dense becoming dense silty gravel (GM) or silty sand (SM)
- **Test Section 3:** Loose silty sand (SM)
- **Test Section 4:** Loose organic silt (OL) or silty sand (SM)

No groundwater was encountered in any boreholes during drilling.

## **2.5 FALLING WEIGHT DEFLECTOMETER TESTING (FWD)**

On 8-5-09 the WSDOT Materials Laboratory conducted pre-construction falling weight deflectometer (FWD) testing along the roadway. The FWD is a non-destructive testing device used to evaluate the physical properties of the pavement section and near surface soils. The device is capable of applying dynamic loads to the pavement surface, similar in magnitude and duration to that of a heavily loaded commercial vehicle. The pavement vertical deflection combined with known layer thicknesses are then used to calculate the in-situ resilient elastic moduli of the pavement structure and subgrade moduli of the underlying soils. This information is then used to predict reaction to the pavement structure and subgrade soils from long-term traffic loading.

Testing was performed in the center of each lane at 200-foot intervals. In general, testing found a significant difference in total deflection of the pavement structure when comparing combined Test Sections 1 and 2, and Test Sections 3 and 4. An increase in deflection is an indicator of reduced capacity to support traffic loads over time before failure of the roadway. Deflections are measured in mils. A mil is a linear unit of diameter equal to 0.001 of an inch. Average deflections for Test Sections 1 and 2 were typically below 20 mils. In Test Sections 3 and 4, deflections were recorded near or above 30 mils.

Recorded subgrade moduli were comparable to measured deflections. The higher the subgrade moduli value, the more suitable the underlying soils are to withstand traffic loading over time. The uncorrected subgrade moduli measured in Test Sections 1 and 2 averaged about 40,000 pounds per square inch (psi). In Test Sections 3 and 4, the recorded subgrade moduli generally ranged below 15,000 psi.

During testing, the affected area or extent of the deflection was also recorded. In general, the longer the extent or length of deflection, the stiffer the asphalt structure. The overall area of each test location along the entire roadway was consistently measured to be on the order of 18 feet. A value falling within this deflection extent would relate to a relatively thin asphalt structure (less than 4 inches in depth). FWD test data is included in Appendix C. A summary of pre-construction FWD values are presented in Table 7.

<b>TABLE 7</b>									
<b>SE 416<sup>th</sup> Street Overlay</b>									
<b>Pre-Construction Falling Weight Deflectometer Value Averages</b>									
	Test Section 1		Test Section 2		Test Section 3		Test Section 4		Overall Roadway Average
	Right	Left	Right	Left	Right	Left	Right	Left	
Deflection (mils)	18	13	17	14	34	36	27	35	24
Subgrade Moduli (ksi)	51	42	38	45	12	11	13	11	28
Area (ft)	17	18	17	18	17	18	18	18	18

**Note:** Right = Eastbound Lane  
Left = Westbound Lane  
ksi = Kips per Square Inch

### **3.0 PRELIMINARY MATERIALS TESTING**

#### **3.1 WSDOT MATERIALS LABORATORY PRELIMINARY MATERIALS TESTING**

For this project, the WSDOT Materials Laboratory served as the primary leader for developing the HMA job mix design. A HMA mix design using the proposed virgin asphalt binder and aggregates was first developed by the Contractor, Woodworth and Company. The design was then submitted to WSDOT for further development and the incorporation of RAP/RAS materials into the final HMA job mix design. We understand that the WSDOT Materials Laboratory is providing a separate report documenting the methods, procedures, and outcome of the mix design.

In general, it was determined that the target value for the virgin asphalt binder content alone was 5.6 percent by weight of the total mix. When including 15 percent RAP and 3 percent RAS, the proportions were recommended at 4.3 percent virgin asphalt binder, 0.6 percent asphalt binder from RAP, and 0.7 percent asphalt binder from RAS. The final mix design is included in Appendix D.

#### **3.2 KCML PRELIMINARY MATERIALS TESTING**

KCML's responsibility for preliminary materials testing was limited to equipment calibration and RAS testing for gradation, extraneous materials, and moisture, prior to mixing with RAP. In addition, we sampled the initially proposed designated stockpile of RAS for asbestos testing. Asbestos testing was performed by others.

### **3.2.1 Preliminary Asbestos Sampling and Testing for RAS**

This report provides a brief summary of KCML involvement in sampling and testing for asbestos in RAS. We understand a detailed account of the testing process and documented events will be prepared by others.

For this project, the RAS supplier was responsible for inspecting and verifying that RAS materials used were free of asbestos containing material. During a site visit to the asphalt plant on 8-11-09, we were directed by RSD Management to sample and deliver materials obtained from the proposed designated RAS stockpile for asbestos testing. Twenty random samples were obtained from the stockpile. The materials were then delivered to the selected testing companies by King County Maintenance Environmental Unit personnel.

Each sample was tested for asbestos using Polarized Light Microscopy (PLM). PLM test results showed no detection of asbestos. Of the twenty samples, five sub-samples were additionally tested using Transmission Electron Microscopy (TEM). The test results found that 3 of the 5 sub-samples contained above one percent of asbestos, ranging from 1.64% to 5.94%. On the basis of these findings the project was put on temporary hold until this issue could be resolved.

Upon consultation with King County and their Consultants, the Contractor prepared a new and separate stockpile, removing asbestos suspect materials including tar paper, shingles with aluminum coating, rolled up roofing, mastic, and patching materials. The newly created stockpile was then tested for asbestos and none was detected.

### **3.2.2 Preliminary Testing of RAS for Gradation, Extraneous Materials, and Moisture**

Three RAS samples were obtained at the final accepted Plant stockpile on 9-10-09 by SWD personnel and delivered to our laboratory for acceptance testing. Each sample was tested for conformance to project specifications for gradation, extraneous materials, and moisture content. Project specifications were as follows:

**Gradation Requirements:** The final RAS product shall be processed so that 100 percent passes the ½ sieve and a minimum of 95 percent passes the 3/8 inch sieve when tested in accordance with the test method in WSDOT Materials Manual "FOP for WAQTC/AASHTO for Sieve Analysis of Fine and Coarse Aggregates (WSDOT Test Procedure T 27/11).

**Requirements Regarding Extraneous Waste Materials:** The final RAS product to be used in the HMA shall be substantially free of extraneous waste materials and entirely free of whole, intact nails. Lighter extraneous material such as paper, wood and plastic shall not exceed 1.5 percent by mass as determined on material retained on the No. 4 sieve. Total extraneous materials including metals, glass, rubber, nails, soil, brick tars, paper, wood and plastic shall not exceed 3.0 percent by mass as determined on material retained on the No. 4 sieve. The method of sampling and testing shall be in accordance with "FOP for AASHTO Standard Practice for Sampling Aggregates" and "FOP for WAQTC/AASHTO Sieve Analysis of Fine and Coarse Aggregates (WSDOT Test Methods T 2 and T 27/11).

**RAS Moisture Content:** The final RAS product to be used in the HMA shall not contain

more than 5.0 percent moisture when tested in accordance with "FOP for AASHTO Total Evaporable Moisture Content of Aggregate by Drying (WSDOT Test Method T 255). The Shingle Recycling Operator shall take the necessary steps to ensure excessive moisture is not retained in the RAS stockpiles.

The RAS final stockpile test results are summarized in the Table 8 and included in Appendix D.

<b>TABLE 8</b>				
<b>SE 416<sup>th</sup> Street Overlay</b>				
<b>RAS Final Stockpile Test Results Summary</b>				
<b>Test Procedure</b>	<b>Requirement</b>	<b>Lab Sample KC-09-1122</b>	<b>Lab Sample KC-09-1123</b>	<b>Lab Sample KC-09-1124</b>
Gradation, 1/2-inch sieve	100% Passing	99%	98%	98%
Gradation, 3/8-inch sieve	95% Minimum Passing	94%	92%	93%
Lighter Extraneous Material	1.5% Maximum	0.06%	0.01%	0.03%
Total Extraneous Material	3.0% Maximum	0.06%	0.01%	0.03%
Moisture Content	5.0% Maximum	10.0%	9.3%	10.8%

Test results revealed that the materials sampled did not meet the gradation or moisture content requirements. The materials did meet the requirements regarding extraneous waste materials.

We understood the RAS materials would be further reduced in size as the material was blended with RAP in the final grind, prior to entering into the mixing drum. In addition, for this project, the initial moisture content was not a critical issue. Generally, excessive water content is a concern if the material was first purchased separately from the RAS supplier, based on total weight. For this project, the Contractor served as both the RAS and HMA supplier. The known moisture content was used to aid in adjusting the mix proportions during production.

Therefore, in our opinion, the RAS materials substantially met the engineering intent for this project and were accepted for use

#### **4.0 CONSTRUCTION INSPECTION AND QUALITY CONTROL TESTING**

The Contractor, Woodworth & Company, began construction operations on 9-21-09 and proceeded through 9-25-09. The work was accomplished in warm dry weather throughout the week. A summary of work performed each day is presented below.

### ***Road Preparation (9-21-09)***

The Contractor prepared the roadway for paving, which included grinding existing pavement at intersections to match grades, removal of raised reflectors, and preleveling areas with conventional HMA to provide for the required finish grade. The thickness and extent of the preleveled locations were documented by King County Construction Services (KCCS) inspection personnel.

### ***Paving Day 1 (9-22-09)***

The Contractor began overlay operations at the east end of the project (244<sup>th</sup> Avenue SE), paving Test Section 4 with the RAP only HMA mix. KCML performed all required testing to verify the quality and placement of the job mix. These tests included asphalt binder content, gradation, maximum theoretical specific gravity, volumetric tests, and in-place density tests.

KCCS verified and recorded material quantities, weather conditions, laydown temperature, equipment and personnel used, and the extent of preleveling on other test sections. In addition, the Contractor provided their own testing services to further confirm the quality of materials and laydown procedures. Test results verified the HMA job mix, mix placement, and compaction met project specifications.

In preparation of paving with the RAP/RAS mix the following day, the Contractor requested a conference call with King County and WSDOT personnel regarding adjustment of the virgin asphalt binder. Based on their experience utilizing recycled shingles in previous projects placed on private property, the Contractor was concerned that the RAS portion of the mix would not fully function as an asphalt binder when incorporated into the mix.

Therefore, the Contractor recommended to increase the virgin asphalt binder by 0.2 percent, for a total of 4.5 percent virgin asphalt binder, while still maintaining 15.0 percent RAP and 3.0 percent RAS for Test Section 3. It was the consensus of all parties to modify the mix as described above.

### ***Paving Day 2 (9-23-09)***

The Contractor paved Test Section 3 with the RAP/RAS added HMA mix. Test results found high asphalt binder content ranging above 6 percent. In addition, the fines content (aggregate materials passing the U.S. #200 sieve) was at or slightly above the maximum amount allowed. The air void content of the mix was also much lower than anticipated. In-place density tests were above 96 percent of the maximum theoretical specific gravity, confirming the low air void content.

The high asphalt binder content and increase in fines were not visually apparent on the pavement surface. The surface appeared similar to Test Section 4 placed the previous day. In addition, recycled shingle fragments were not obviously noted. Upon careful examination, however, some very small pieces of shingle fragments could be found.

Following placement, all parties met and agreed that the RAP/RAS HMA mix needed to be adjusted prior to proceeding to Test Section 2. It was decided that the Contractor could proceed to pave Test Section 1 on 9-24-09 using the RAP only HMA mix.

### ***Paving Day 3 (9-24-09)***

As agreed by all parties, Test Section 1 was paved using the RAP only HMA mix. Test results verified satisfactory quality of the job mix and acceptable placement and compaction.

In preparation of paving Test Section 2 with the RAP/RAS HMA mix the following day, the Contractor recommended to lower the virgin asphalt binder content back to the level proposed in the mix design (4.3 percent). In addition, the Contractor would attempt to reduce the fines content in the overall mix by cleaning out the baghouse.

### ***Paving Day 4 (9-25-09)***

The Contractor completed overlay operations by paving Test Section 2 with the adjusted RAP/RAS HMA mix. Testing indicated that the quality of the job mix was now in compliance. However, the fines content of the aggregate still ranged within the upper limits of the specification. Compaction testing indicated the average relative density of the new overlay to be slightly over the minimum requirement of 92 percent of the maximum theoretical specific gravity.

The appearance of the pavement surface was typical of a well-placed and compacted HMA roadway. A few intermittent shingle fragments and extraneous materials including wood, rubber, glass and wire could be located and pulled from the compacted surface. The diameter of these materials was generally less than 1/2-inch in thickness. However, some RAS fragments, in the shape of strands, measured nearly 4 inches in length.

Documentation during construction, including daily field reports, density test results, and all other related laboratory test results is provided in Appendix E.

## **5.0 POST-CONSTRUCTION TESTING**

Following final paving operations, the roadway was restriped and immediately opened to traffic. In addition, stationing was reestablished to use as a reference for post-construction testing and documentation. Post-construction testing included pavement condition rating utilizing the WSDOT distress data collection van, recording deflections using the WSDOT falling weight deflectometer, and skid resistance testing conducted by the King County Sheriff's office.

## 5.1 POST-CONSTRUCTION PAVEMENT CONDITION SURVEY (WSDOT)

On 12-2-09, the WSDOT Materials Laboratory conducted a post-construction pavement condition survey utilizing the distress data collection van. Test results from the WSDOT post-construction pavement condition survey are summarized below in Table 9.

<b>TABLE 9</b>			
<b>SE 416<sup>th</sup> Street Overlay</b>			
<b>WSDOT Post-Construction Pavement Condition Survey</b>			
<b>Test Section</b>	<b>PSC</b>	<b>PRC</b>	<b>IRI</b>
Test Section 1	100	95.6	68
Test Section 2	99.8	97.6	60
Test Section 3	100	95.0	88
Test Section 4	99.7	96.1	78
Overall Rating	99.9	96.1	74

**Notes:** PSC = Pavement Structural Condition (WSDOT)  
PRC = Pavement Rutting Condition (WSDOT)  
IRI = International Roughness Index (inches/mile)

The survey revealed that the newly paved roadway surface is in near perfect visual condition with minutely recorded rutting. The roughness (IRI) of the roadway measured below 95 in all Test Sections indicating a relatively smooth surface. However, Test Sections 3 and 4 rated about 20 points higher than Test Sections 1 and 2. This may be due to traveling over the existing Newaukum Creek Bridge located in Test Section 3 and/or accelerating or decelerating during testing.

The survey will serve as a baseline for documenting deterioration of each roadway Test Section over time.

## 5.2 POST-CONSTRUCTION FALLING WEIGHT DEFLECTOMETER TESTING

WSDOT Materials Laboratory also conducted post-construction falling weight deflectometer (FWD) testing along the roadway on 10-14-09. Data obtained from testing is in the process of analysis. Analysis of the information was not completed prior to the release of this report and will be included in a supplemental report.

## 5.3 SKID RESISTANCE TESTING

Roadway skid resistance testing was conducted by the Major Accident Response and Reconstruction Unit (MARR) of the King County Sheriff's office. Within each Test Section, skid resistance testing was performed during dry pavement conditions on 10-12-09 and during wet pavement conditions on 1-04-10.

The tests were conducted using both Vericom VC 2000 and VC 3000 Braking Computer Systems. The braking computer system calculates a drag factor which is used throughout the accident reconstruction industry as an indicator of skid resistance, and has been used

by the MARR Unit for over 15 years involving thousands of test skids. The drag factor is a unitless value and is used to calculate the resistance of an object in motion. According to Vericom's website, the normal range for drag factors of various vehicles is presented in Table 10.

<b>TABLE 10</b>	
<b>SE 416<sup>th</sup> Street Overlay</b>	
<b>Normal Range for Drag Factor (F)</b>	
Passenger Vehicles with Standard Brakes	0.75 ± 5%
Passenger Vehicles with ABS Brakes	0.85 ± 5%
Motorcycles	0.9 ± 10%
Commercial Vehicles	0.62 ± 10%

**Note:** Pickup trucks are 5% less than a passenger vehicle.

Vehicles used during dry skid resistance testing included a 2007 and 2009 Ford Expedition, a 2005 Ford Taurus and a 1999 Dodge Caravan. One 2006 Ford Expedition, two 2007 Ford Expeditions, and one 2009 Ford Expedition were utilized during wet skid resistance testing. When available, tests were conducted using both conventional braking and anti-lock braking (ABS) systems. A summary of the skid test results for both dry and wet surface conditions are summarized in Table 11.

<b>TABLE 11</b>				
<b>SE 416<sup>th</sup> Street Overlay</b>				
<b>Drag Factor Test Results in Both Dry and Wet Road Conditions</b>				
Test Section	Dry Roadway		Wet Roadway	
	Conventional Braking	Anti-Lock Braking	Conventional Braking	Anti-Lock Braking
Test Section 1	0.71	0.83	0.66	0.79
Test Section 2	0.70	0.86	0.68	0.82
Test Section 3	0.67	0.81	0.66	0.80
Test Section 4	0.72	0.87	0.73	0.83
Overall Rating	0.70	0.84	0.68	0.81

Test results indicated that the overall skid resistance for both dry and wet conditions recorded on SE 416<sup>th</sup> Street was comparable to those found on other similar King County Roadways. Skid resistance test reports submitted by the MARR Unit of the King County Sheriff's Office are included in Appendix E.

## 6.0 CONTINUING TESTING AND ANALYSIS

Continuing testing and analysis in support of the demonstration project, and to supplement this report, will include the combined analysis of falling weight deflectometer data, current pavement thicknesses, subsurface conditions, and traffic analysis to predict the long-term performance of each Test Section.

Based upon the refined predictions, we will then be able to more accurately determine the impact of using RAS in HMA. The analysis is expected to be completed and made available for distribution by March 2010. A walking pavement condition survey will also be conducted by KCML to provide an additional baseline for determining long-term performance.

KCML is further committed to closely monitor the structural performance of the roadway for a minimum of three years. At that time, a judgment on the long-term structural impact of using post-consumer shingles could then be considered. Further monitoring and analysis of the retrieved data will include the following procedures:

- Conduct a yearly pavement condition survey by walking the site and documenting all distressed areas.
- Conduct a yearly pavement condition survey utilizing the WSDOT distress data collection van.
- After three years of service, conduct skid testing in both dry and wet conditions.
- Perform analysis of the above retrieved data and submit a supplemental report summarizing the findings and provide recommendations for the continued use of RAS on public roadways in King County.

## **7.0 SUMMARY, FINDINGS, AND CONCLUSIONS**

### **7.1 SUMMARY**

We have completed our initial documentation and analysis of the SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration. The purpose of the Demonstration project was to determine the consequence of incorporating recycled asphalt shingles (RAS) into the total HMA mix design. The use of post-consumer (tear-off) shingles in roadway paving is a relatively new concept. This project represents the first known attempt to incorporate RAS into a HMA job mix for use on a public roadway in King County.

The demonstration project allowed for the use of 3 percent RAS and 15 percent RAP in the total HMA mix. Preliminary HMA mix design testing was conducted by the WSDOT Materials Laboratory in Tumwater, Washington. To determine short term and long term impacts, KCML developed and implemented a program to document the pre-construction condition of the roadway. Construction was closely monitored by documenting field activities and performing quality control testing on the materials used and their placement. Initial post-construction testing was then conducted to provide a baseline for future evaluation and documentation on the long-term performance of this roadway.

## **7.2 FINDINGS**

### **7.2.1 Pre-Construction Conditions**

#### ***Pre-Construction Pavement Condition Surveys***

Pavement condition ratings between KCML and WSDOT varied significantly when comparing pavement condition indexes (PCI). KCML documented an overall rating of 66 as compared to an overall rating of 31 recorded by WSDOT. This is likely due to the subjective and qualitative interpretation for the rated severity of observed distressed areas.

The majority of deteriorated sections were located in the wheel paths of the roadway. KCML interpreted the majority of cracking as low severity longitudinal cracking, while WSDOT generally measured these distresses as moderately severe. In addition, KCML designated the newly placed asphalt patching constructed by King County Maintenance in May 2009 as low severity. WSDOT documented the patching as medium severity.

Despite the discrepancy of the qualitative analysis of the pavement surface, data from both surveys can and will be used to aid in determining future deterioration of the pavement, providing valuable information as one indicator for the long-term performance of the roadway.

The pre-construction pavement rutting condition survey revealed minimal rutting within the roadway. Rutting values were similar in all Test Sections. The roughness condition for Test Sections 1 and 2 rated very good. Test Sections 3 and 4 rated from good to fair, respectively.

#### ***Pre-Construction Physical Testing Summary***

Physical testing of the roadway, included determination of asphalt thickness, observation of subsurface conditions, and falling weight deflectometer (FWD) testing. Retrieved asphalt cores measured an average thickness of 4.5 inches in Test Sections 1 through 3 and 5.5 inches in Test Section 4. In general, underlying soils in Test Sections 1 and 2 consisted of medium dense silty gravel or silty sand. Underlying soils in Test Sections 3 and 4 consisted of loose silty sands or organic silt.

FWD testing further verified underlying subgrade strengths. Test Sections 1 and 2 measured uncorrected subgrade moduli of roughly 40,000 psi. The recorded uncorrected subgrade moduli in Test Sections 3 and 4 were generally below 15,000 psi. The above data will be used in a future report to predict the long-term performance for each Test Section.

## **7.2.2 Preliminary Materials Testing**

### ***Preliminary Asbestos Testing Sampling and Testing for RAS***

Test results using polarized Light Microscopy (PLM) methods detected no asbestos in the initial designated processed RAS stockpile. However, additional testing using Transmission Electron Microscopy (TEM) techniques did result in detecting a small percentage of asbestos in some samples.

To ensure substantial absence of asbestos in the finish RAS product, another stockpile was prepared by carefully hand sorting the shingles and removing felt, tar paper, patching material and other deleterious material that may contain asbestos. No asbestos was detected following testing of the new stockpile. This indicates that with proper sorting and inspection, RAS can be processed in a manner resulting in an asbestos-free product. Accepted processing and testing protocols are needed and must be followed to sufficiently address environmental issues when commonly using RAS.

### ***Preliminary Testing of RAS for Gradation, Extraneous Materials, and Moisture***

Preliminary testing prior to production revealed that the RAS samples did not specifically meet the gradation requirements. In addition, the moisture content was above specification limits. The amount of extraneous materials found was below the maximum required limit.

We understood, for this project, the RAS would be further reduced in size when mixed and re-ground with RAP, prior to entering the drum mixer. In addition, the mix was adjusted to account for the amount of water during production. Therefore, we believed the product was adequate for use in this project. Further standardized processing techniques and quality control measures may need to be implemented, if RAS is to be routinely incorporated into the HMA mix.

## **7.2.3 Construction, Inspection, and Quality Control Testing**

Construction inspection and quality control testing verified that, except for Test Section 3, all Test Sections substantially met project specifications and materials verification. In Test Section 3, high virgin asphalt binder content in concert with, to a lesser extent, high aggregate fines content led to low air voids in the HMA job mix. In-place density tests further verified air void loss.

It was evident the addition of virgin asphalt binder in Test Section 3 was not needed to supplement the suspected lack of functional RAS-embedded asphalt binder. The fuller release of these binders may be attributed to double grinding RAS before entry into the drum mixer.

The graded size of RAS and interdependent relationship with the total percent of asphalt binder released during mixing requires further study to ensure a consistent and reliable HMA job mix.

The finished pavement surface of all Test Sections appeared relatively smooth and well compacted, typical of a well placed and compacted conventional HMA pavement. Upon careful inspection, a few strands of roofing fragments could be observed and removed from the pavement surface. Initial findings indicate that a HMA job mix that includes up to 3 percent RAS by total weight can be successfully mixed, placed and compacted to the standards required of a conventional HMA mix.

#### **7.2.4 Post-Construction Testing**

##### ***Pavement Condition Survey***

The post-construction survey conducted by WSDOT utilizing the distress data collection van revealed that the finished roadway surface is in near perfect visual condition with minutely recorded rutting. The roughness of the roadway measured below 95 in all Test Sections indicating a relatively smooth surface. However, Test Sections 3 and 4 rated about 20 points higher than Test Sections 1 and 2. This may be due to traveling over the existing Newhaukem Creek Bridge located in Test Section 3 and/or accelerating or decelerating during testing.

The survey will serve as a baseline for documenting deterioration of each roadway Test Section over time.

##### ***Skid Resistance Testing***

Each Test Section recorded favorable skid resistance in both dry and wet conditions that would be commonly found on other similar King County Roadways. Initial test results indicate that incorporating a maximum of 3 percent RAS in the HMA job mix does not negatively impact nor significantly improve the skid resistance of the pavement surface.

##### ***Falling Weight Deflectometer Testing (FWD)***

Analysis of data obtained from FWD testing has currently not been completed. A supplemental report will include the combined analysis of falling weight deflectometer data, current pavement thicknesses, subsurface conditions, and traffic analysis to predict the long-term performance of each Test Section. The supplemental report is scheduled for completion in March, 2010.

#### **7.3 CONCLUSIONS**

The initial use and performance of 3 percent RAS has had no impact, favorable or detrimental, when incorporated into the HMA job mix. Skid resistance testing shows that there was no noticeable change in resistance when including this material. Only a long-term study of the roadway will provide conclusive evidence of its performance. Further

testing, analysis, and documentation on the long-term performance of this roadway will continue for a minimum of three years to verify the impact on using RAS on public roadways in King County.

Respectfully Submitted,

King County Materials Laboratory



Alan D. Corwin, P.E.  
Materials Engineer

A handwritten signature in cursive script, appearing to read "Kevin L. Kelsey".

Kevin L. Kelsey  
Senior Engineer

## **8.0 REFERENCES**

ASTM Standards, Volume 04.03, *ASTM D 6433-07 Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys*, 2009.

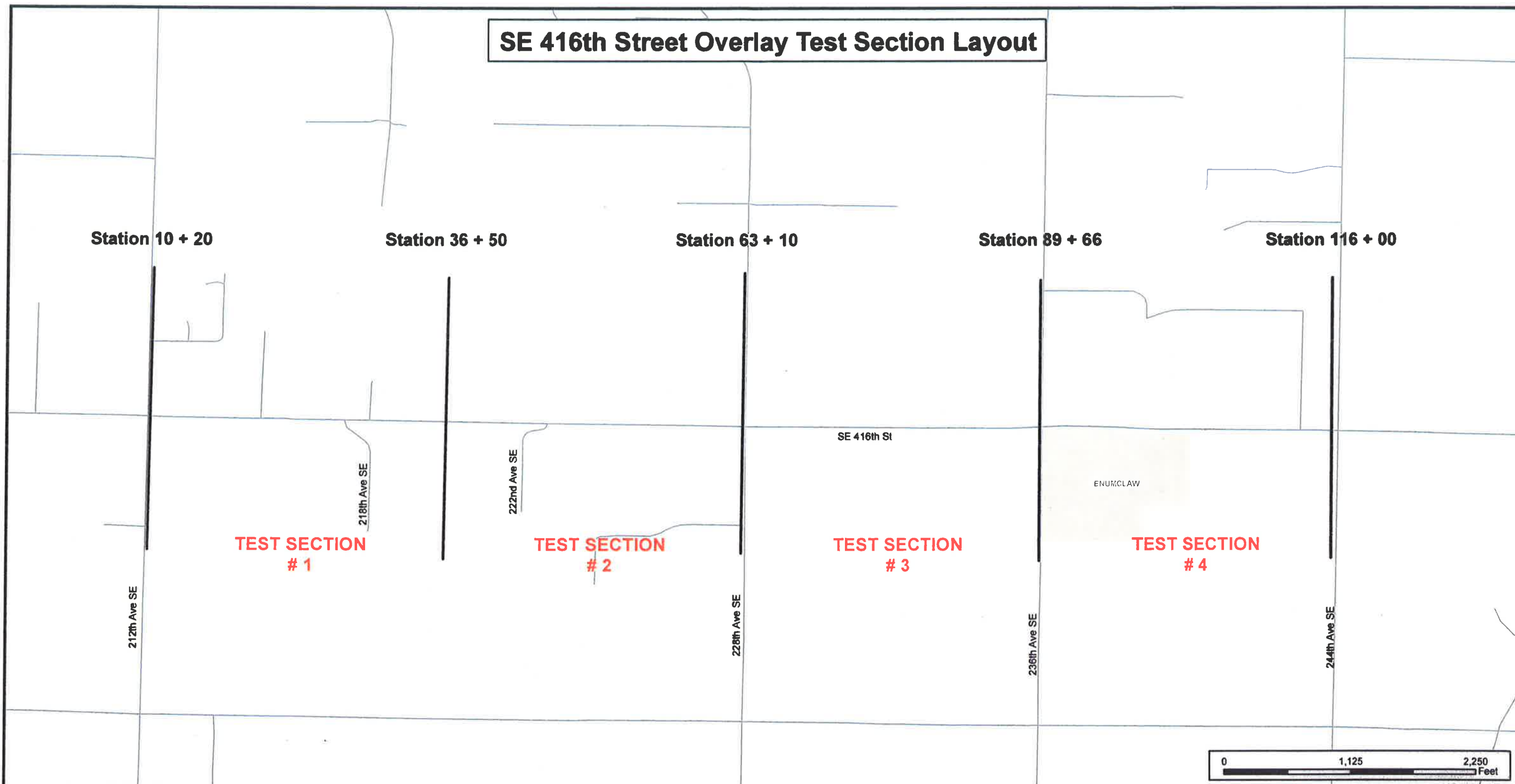
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# SE 416th Street Overlay Test Section Layout



## King County Materials Laboratory

SE 416th Street Overlay  
Shingles in Paving Demonstration

### TEST SECTION LAYOUT

Figure 2

— Station Line  
— Street Network



January 7, 2010

File Name:  
KG T\Development\ArcMap\ArcMapProjects\SE\_416th\_St\_test\_section\_map.mxd  
Data Sources:  
Standard King County datasets used include: trans\_network  
Roads Datasets include: SE416thSt\_stationing

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**King County**  
Department of Transportation  
Road Services Division  
Technology Unit

# **APPENDIX A**

## **SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration Technical Support Document**

### **RAS Study Roadway Candidate Selection Criteria**

### **King County Materials Laboratory Pre-Construction Pavement Condition Survey**

RAS STUDY - ROADWAY CANDIDATE SELECTION CRITERIA

RATING CRITERIA	EXISTING HMA THICKNESS 4+ INCHES					EXISTING CONDITION/LEVEL OF DETERIORATION					CONSISTENT AND STABLE SUBGRADE					NO DEVELOPMENT PLANNED IN 10 YEARS THAT WOULD DISTURB ROADWAY					NO OR LIMITED DRAINAGE ISSUES					ROADWAY HAD SUFFICIENT AMOUNT OF TRUCK TRAFFIC					TYPICAL TWO-LANE ROADWAY					ROAD LENGTH A MINIMUM OF 2 MILES					LIMITED STOP AND GO, TURNING					FLAT AND STRAIGHT ROADWAY				
MAXIMUM CATEGORY SCORE	100					100					75					75					50					50					50					40					25					25				
ROAD DESIGNATION	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.	SE NORTH BEND WAY	196TH AVE. SE	148TH AVE SE	212TH AVE SE	SE 416TH ST.					
D. Walters	40	50	50	50	50	45	70	50	45	35	50	35	35	30	30	35	50	50	50	35	40	40	25	20	20	30	25	15	20	25	12	40	40	40	40	20	40	40	40	40	10	20	20	15	15	12	12	10	20	25
K. Kelsey	75	65	70	50	65	80	75	50	65	50	60	40	65	65	50	40	60	60	60	55	50	35	35	35	30	40	17	25	20	25	15	40	50	40	45	20	40	30	20	40	15	17	20	20	20	17	12	15	20	20
R. Lee	50	70	70	40	70	80	60	50	80	80	40	40	70	70	60	35	50	60	70	65	25	45	45	45	45	50	40	20	25	45	12	45	50	30	50	40	40	40	40	10	20	20	20	20	10	8	20	25	20	
P. Moore	20	60	50	50	75	50	50	50	40	50	40	40	40	35	35	15	40	30	50	50	30	30	25	40	50	40	25	20	20	30	15	25	30	50	50	30	40	30	40	40	15	15	20	25	25	10	5	15	25	25
A. Corwin	70	80	80	40	70	70	80	50	60	50	70	65	60	60	60	70	60	70	70	65	40	40	40	40	35	40	40	30	40	30	20	50	40	50	50	30	40	40	40	40	20	20	25	20	20	20	15	15	20	25
REVIEWER 6																																																		
TOTAL (Per Road, Per Category)	255	325	320	230	330	325	335	250	290	265	260	220	270	260	235	195	260	270	300	270	185	190	170	180	180	200	147	110	125	155	74	200	210	210	235	140	200	180	180	200	70	92	105	100	100	69	52	75	110	115

	TOTAL (Per Reviewer, Per Road)	TOTAL (All Reviewers, Per Road)
SE NORTH BEND WAY	294	1773
196TH AVE. SE	412	2021
148TH AVE SE	352	1960
212TH AVE SE	265	1985
SE 416TH ST.	450	2085

# KING COUNTY MATERIALS LABORATORY

## SE 416TH STREET OVERLAY - PAVEMENT CONDITION SURVEY

<b>TEST SECTIONS 1, 2, 3 AND 4</b>  <b>STATION 10+20 TO 116+00</b>  <b>AREA: 232,760 SQ. FT. (22 FT. X 10,580 FT.)</b>	8L: LOW SEVERITY PATCH (SQ. FT.)	8M: MODERATE SEVERITY PATCH (SQ. FT.)	5L: LOW SEVERITY TRANSVERSE CRACKING (LIN. FT.)	5M: MODERATE SEVERITY TRANSVERSE CRACKING (LIN. FT.)	3L: LOW SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	3M: MODERATE SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	2L: LOW SEVERITY ALLIGATOR CRACKING (SQ. FT.)	2M: MODERATE SEVERITY ALLIGATOR CRACKING (SQ. FT.)	1M: MODERATE SEVERITY RUTTING (SQ. FT.)
	DISTRESS QUANTITIES	52021	992	993	22	10535	853	2006	1764
	DISTRESS DENSITY IN PERCENT	22.31	0.43	0.43	0.01	4.52	0.37	0.86	0.76
	DISTRESS DEDUCT VALUE	23	6	0	0	10	3	9	15
	MAXIMUM ALLOWABLE # OF DEDUCTS	8.1	MAX. CORRECTED DEDUCT VALUE (CDV)						34.0

ASTM D-6433-07: TEST SECTIONS 1, 2, 3 AND 4 PAVEMENT CONDITION INDEX (PCI)	66.0
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# KING COUNTY MATERIALS LABORATORY

## SE 416TH STREET OVERLAY - PAVEMENT CONDITION SURVEY

TEST SECTION 1			8L: LOW SEVERITY PATCH (SQ. FT.)	8M: MODERATE SEVERITY PATCH (SQ. FT.)	5L: LOW SEVERITY TRANSVERSE CRACKING (LIN. FT.)	5M: MODERATE SEVERITY TRANSVERSE CRACKING (LIN. FT.)	3L: LOW SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	3M: MODERATE SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	2L: LOW SEVERITY ALLIGATOR CRACKING (SQ. FT.)	2M: MODERATE SEVERITY ALLIGATOR CRACKING (SQ. FT.)	1M: MODERATE SEVERITY RUTTING (SQ. FT.)
STATION 10+20 TO 36+50											
AREA: 59,400 SQ. FT. (22 FT. X 2,700 FT.)											
10+20	TO	11+00	266				135				
11+00	TO	12+00	154				200				
12+00	TO	13+00			6		43				
13+00	TO	14+00					91				
14+00	TO	15+00			3		30				
15+00	TO	16+00					163				
16+00	TO	17+00					164				
17+00	TO	18+00					64				
18+00	TO	19+00					90				
19+00	TO	20+00			9		85				
20+00	TO	21+00					110				
21+00	TO	22+00	88				110				
22+00	TO	23+00					213				
23+00	TO	24+00					219				
24+00	TO	25+00					277				
25+00	TO	26+00			3		189		64		
26+00	TO	27+00	70		6		199				
27+00	TO	28+00	980				8	31			
28+00	TO	29+00	504				5		34		
29+00	TO	30+00					117		22		
30+00	TO	31+00			7		106				
31+00	TO	32+00	123				8				
32+00	TO	33+00	452				31				
33+00	TO	34+00	700				13				
34+00	TO	35+00	700		8		29				
35+00	TO	36+00	700		3		3				
36+00	TO	36+50	700		9		10				
DISTRESS QUANTITIES			5437	0	54	0	2712	31	120	0	0
DISTRESS DENSITY IN PERCENT			9.15	0.00	0.09	0.00	4.57	0.05	0.20	0.00	0.00
DISTRESS DEDUCT VALUE			16	0	0	0	10	0	5	0	0
MAXIMUM ALLOWABLE # OF DEDUCTS			8.7	MAX. CORRECTED DEDUCT VALUE (CDV)							22.0

ASTM D-6433-07: TEST SECTION 1 PAVEMENT CONDITION INDEX (PCI)

78.0

# KING COUNTY MATERIALS LABORATORY

## SE 416TH STREET OVERLAY - PAVEMENT CONDITION SURVEY

TEST SECTION 2			8L: LOW SEVERITY PATCH (SQ. FT.)	8M: MODERATE SEVERITY PATCH (SQ. FT.)	5L: LOW SEVERITY TRANSVERSE CRACKING (LIN. FT.)	5M: MODERATE SEVERITY TRANSVERSE CRACKING (LIN. FT.)	3L: LOW SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	3M: MODERATE SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	2L: LOW SEVERITY ALLIGATOR CRACKING (SQ. FT.)	2M: MODERATE SEVERITY ALLIGATOR CRACKING (SQ. FT.)	1M: MODERATE SEVERITY RUTTING (SQ. FT.)
STATION 36+50 TO 63+10											
AREA: 54,420 SQ. FT. (22 FT. X 2,610 FT.)											
36+50	TO	38+00	714				154				
38+00	TO	39+00	1082				31	21			
39+00	TO	40+00	833		12		67	50			
40+00	TO	41+00	700		28		67	70			
41+00	TO	42+00	543		6		180	62			
42+00	TO	43+00	627		14		51	100			
43+00	TO	44+00	287				75	25			
44+00	TO	45+00	46				152				
45+00	TO	46+00	105				103				
46+00	TO	47+00					245				
47+00	TO	48+00					214				
48+00	TO	49+00			21		34	90	40		
49+00	TO	50+00	140				80	60			
50+00	TO	51+00	350				205				
51+00	TO	52+00	350				212				
52+00	TO	53+00	350				93				
53+00	TO	54+00	350		12		17				
54+00	TO	55+00	350		12		173				
55+00	TO	56+00	350				145	9	52		
56+00	TO	57+00	259		3		200	15			
57+00	TO	58+00	35				119				
58+00	TO	59+00	529				168				
59+00	TO	60+00	490		8		96				
60+00	TO	61+00	392				61				
61+00	TO	62+00	700				101				
62+00	TO	63+10	998		10		51				
DISTRESS QUANTITIES			10580	0	126	0	3094	502	92	0	0
DISTRESS DENSITY IN PERCENT			19.44	0.00	0.23	0.00	5.69	0.92	0.17	0.00	0.00
DISTRESS DEDUCT VALUE			22	0	0	0	11	8	5	0	0
MAXIMUM ALLOWABLE # OF DEDUCTS			8.2	MAX. CORRECTED DEDUCT VALUE (CDV)							28.0

ASTM D-6433-07: TEST SECTION 2 PAVEMENT CONDITION INDEX (PCI)	72.0
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# KING COUNTY MATERIALS LABORATORY

## SE 416TH STREET OVERLAY - PAVEMENT CONDITION SURVEY

TEST SECTION 3			8L: LOW SEVERITY PATCH (SQ. FT.)	8M: MODERATE SEVERITY PATCH (SQ. FT.)	5L: LOW SEVERITY TRANSVERSE CRACKING (LIN. FT.)	5M: MODERATE SEVERITY TRANSVERSE CRACKING (LIN. FT.)	3L: LOW SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	3M: MODERATE SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	2L: LOW SEVERITY ALLIGATOR CRACKING (SQ. FT.)	2M: MODERATE SEVERITY ALLIGATOR CRACKING (SQ. FT.)	1M: MODERATE SEVERITY RUTTING (SQ. FT.)
STATION 63+10 TO 89+66											
AREA: 58,300 SQ. FT. (22 FT. X 2,650 FT.)											
63+10	TO	64+00	1022	110	6		4	34		40	
64+00	TO	65+00	1050		10		100				
65+00	TO	66+00	1040				98				
66+00	TO	67+00	1334		4		68				
67+00	TO	68+00	1400				31	26			
68+00	TO	69+00	1096		12						
69+00	TO	70+00	889				80				
70+00	TO	71+00	1050		8		83		132		
71+00	TO	72+00	963	150			76		72		
72+00	TO	73+00	700	600	6				219		
73+00	TO	74+00	973	132			121		203		
74+00	TO	75+00	1050		4		10	63	84		
75+00	TO	76+00	1050						500		
76+00	TO	77+00	1050		8		17		166		
77+00	TO	78+00	1050		16		26		84		
78+00	TO	79+00	576	110	22		78				423
79+00	TO	80+00			45				15		1341
80+00	TO	81+00	626		3	22	110		21		
81+00	TO	82+00	665				87				
82+00	TO	83+00	403		14		193				
83+00	TO	84+00	350		3		23				
84+00	TO	85+00	350		12		139				
85+00	TO	86+00	221		4		90				
86+00	TO	87+00	700		13		153				
87+00	TO	88+00	858		13		65				
88+00	TO	89+00	1302				13				
89+00	TO	89+66	630				60				
DISTRESS QUANTITIES			21376	992	197	22	1721	89	1496	0	1764
DISTRESS DENSITY IN PERCENT			36.67	1.82	0.36	0.04	3.16	0.16	2.75	0.00	3.24
DISTRESS DEDUCT VALUE			28	13	0	0	7	0	20	0	30
MAXIMUM ALLOWABLE # OF DEDUCTS			7.4	MAX. CORRECTED DEDUCT VALUE (CDV)							56.0

ASTM D-6433-07: TEST SECTION 3 PAVEMENT CONDITION INDEX (PCI)

44.0

# KING COUNTY MATERIALS LABORATORY

## SE 416TH STREET OVERLAY - PAVEMENT CONDITION SURVEY

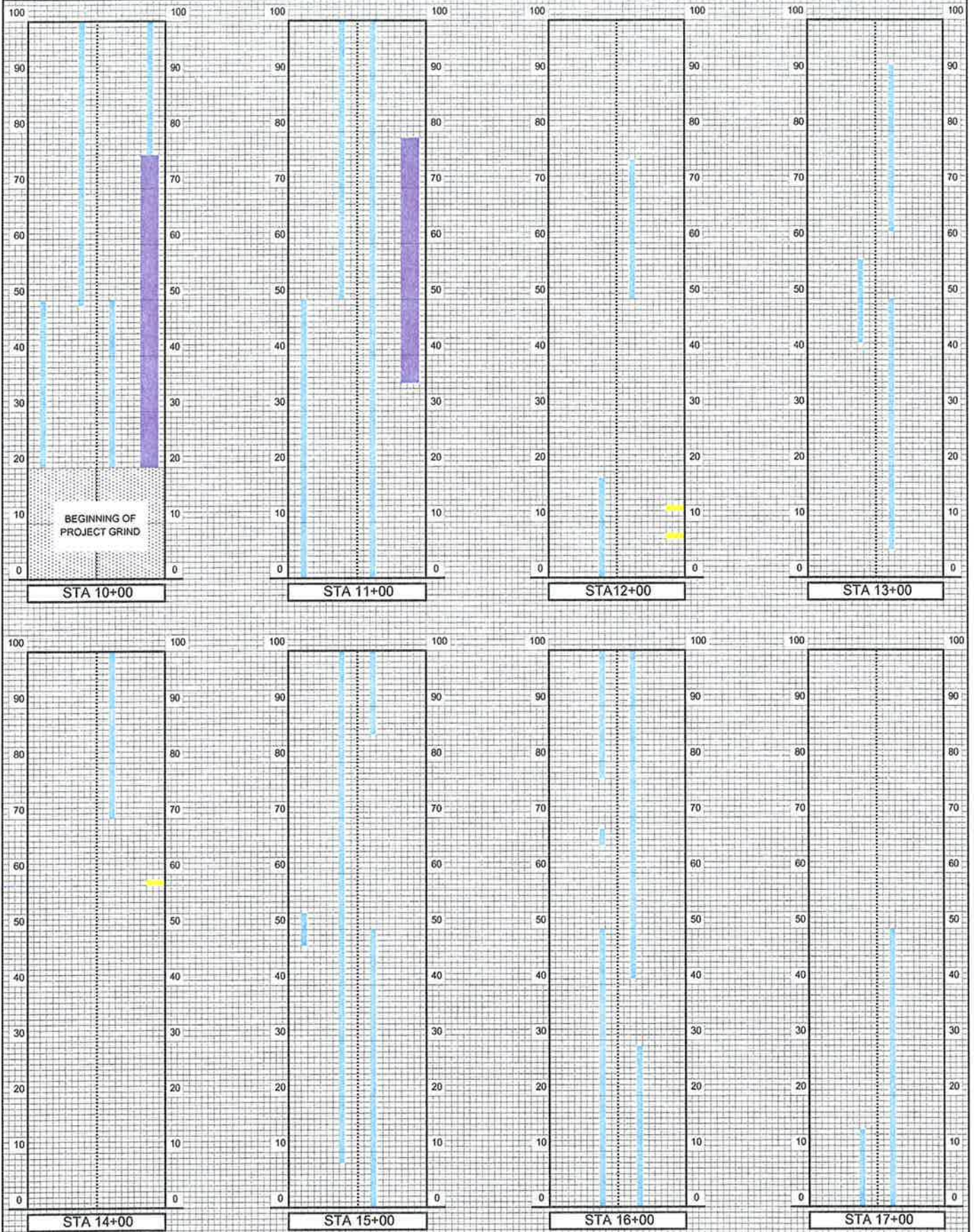
TEST SECTION 4			8L: LOW SEVERITY PATCH (SQ. FT.)	8M: MODERATE SEVERITY PATCH (SQ. FT.)	5L: LOW SEVERITY TRANSVERSE CRACKING (LIN. FT.)	5M: MODERATE SEVERITY TRANSVERSE CRACKING (LIN. FT.)	3L: LOW SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	3M: MODERATE SEVERITY LONGITUDINAL CRACKING (LIN. FT.)	2L: LOW SEVERITY ALLIGATOR CRACKING (SQ. FT.)	2M: MODERATE SEVERITY ALLIGATOR CRACKING (SQ. FT.)	1M: MODERATE SEVERITY RUTTING (SQ. FT.)
STATION 89+66 TO 116+00											
AREA: 58,080 SQ. FT. (22 FT. X 2,640 FT.)											
89+66	TO	90+00	420				40				
90+00	TO	91+00	1029		44		86		9		
91+00	TO	92+00	707		8		107		6		
92+00	TO	93+00	350		6		127				
93+00	TO	94+00	417				126				
94+00	TO	95+00	679		8		90				
95+00	TO	96+00	690				111				
96+00	TO	97+00	350				232	47			
97+00	TO	98+00	350				189	50			
98+00	TO	99+00	350				234	39			
99+00	TO	100+00	350				205	5			
100+00	TO	101+00	350		38		108		4		
101+00	TO	102+00	427				188				
102+00	TO	103+00	1015		3		45				
103+00	TO	104+00	763		25		66				
104+00	TO	105+00	700		35		32				
105+00	TO	106+00	595		47		97				
106+00	TO	107+00	473		49		132				
107+00	TO	108+00	700		15		77				
108+00	TO	109+00	630		55		27				
109+00	TO	110+00	700		21		48				
110+00	TO	111+00	735		36		42	25			
111+00	TO	112+00	735		48		91	35			
112+00	TO	113+00	126		52		169				
113+00	TO	114+00			96		117	30	210		
114+00	TO	115+00	420		30		169		69		
115+00		116+00	987				93				
DISTRESS QUANTITIES			14628	0	616	0	3008	231	298	0	0
DISTRESS DENSITY IN PERCENT			25.19	0.00	1.06	0.00	5.18	0.40	0.51	0.00	0.00
DISTRESS DEDUCT VALUE			25	0	3	0	12	0	6	0	0
MAXIMUM ALLOWABLE # OF DEDUCTS			7.9	MAX. CORRECTED DEDUCT VALUE (CDV)							30.0

ASTM D-6433-07: TEST SECTION 4 PAVEMENT CONDITION INDEX (PCI)

70.0

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 1: HMA MIX WITH 15% RAP - STA 10+20 TO 36+50

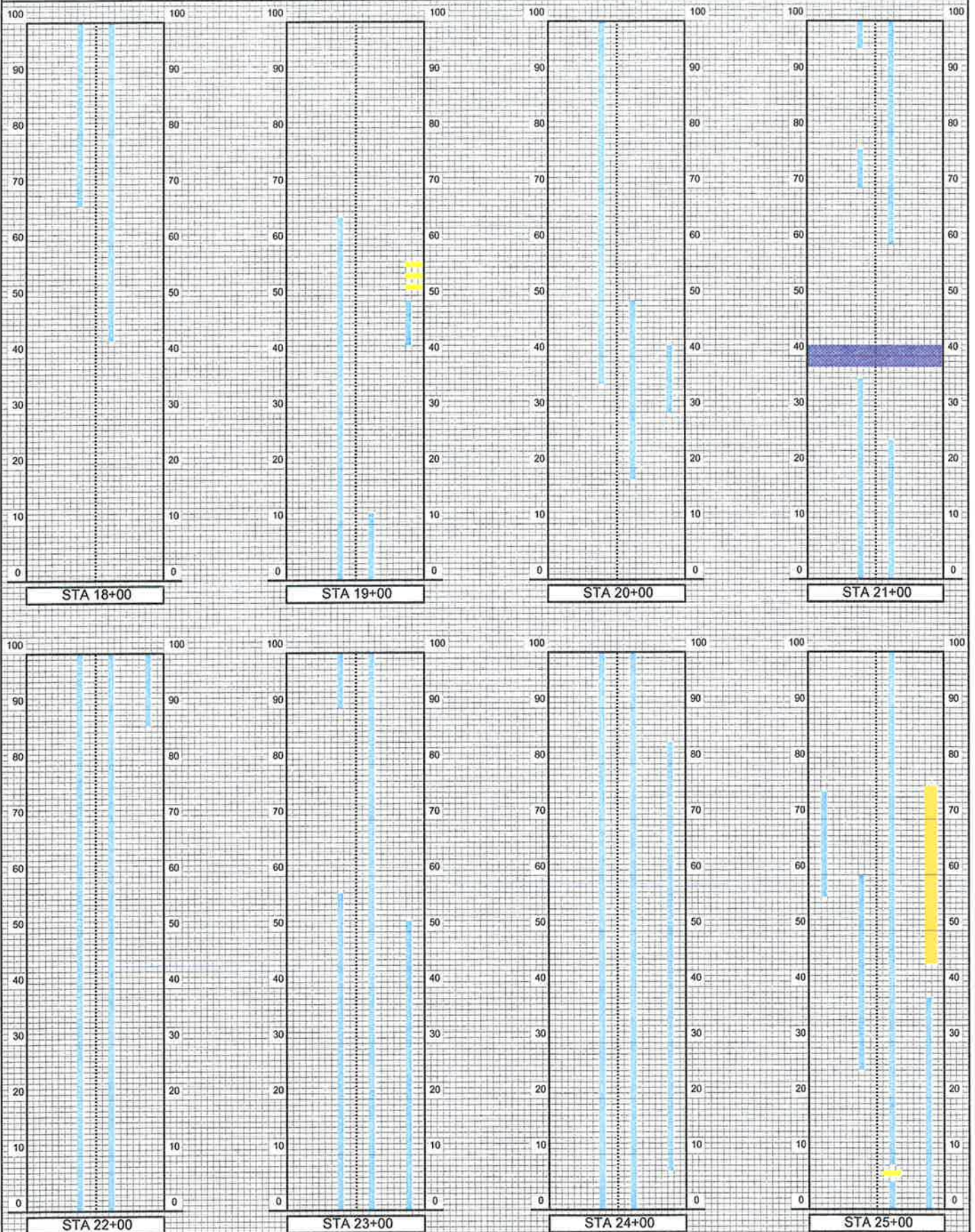


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 1: HMA MIX WITH 15% RAP - STA 10+20 TO 36+50

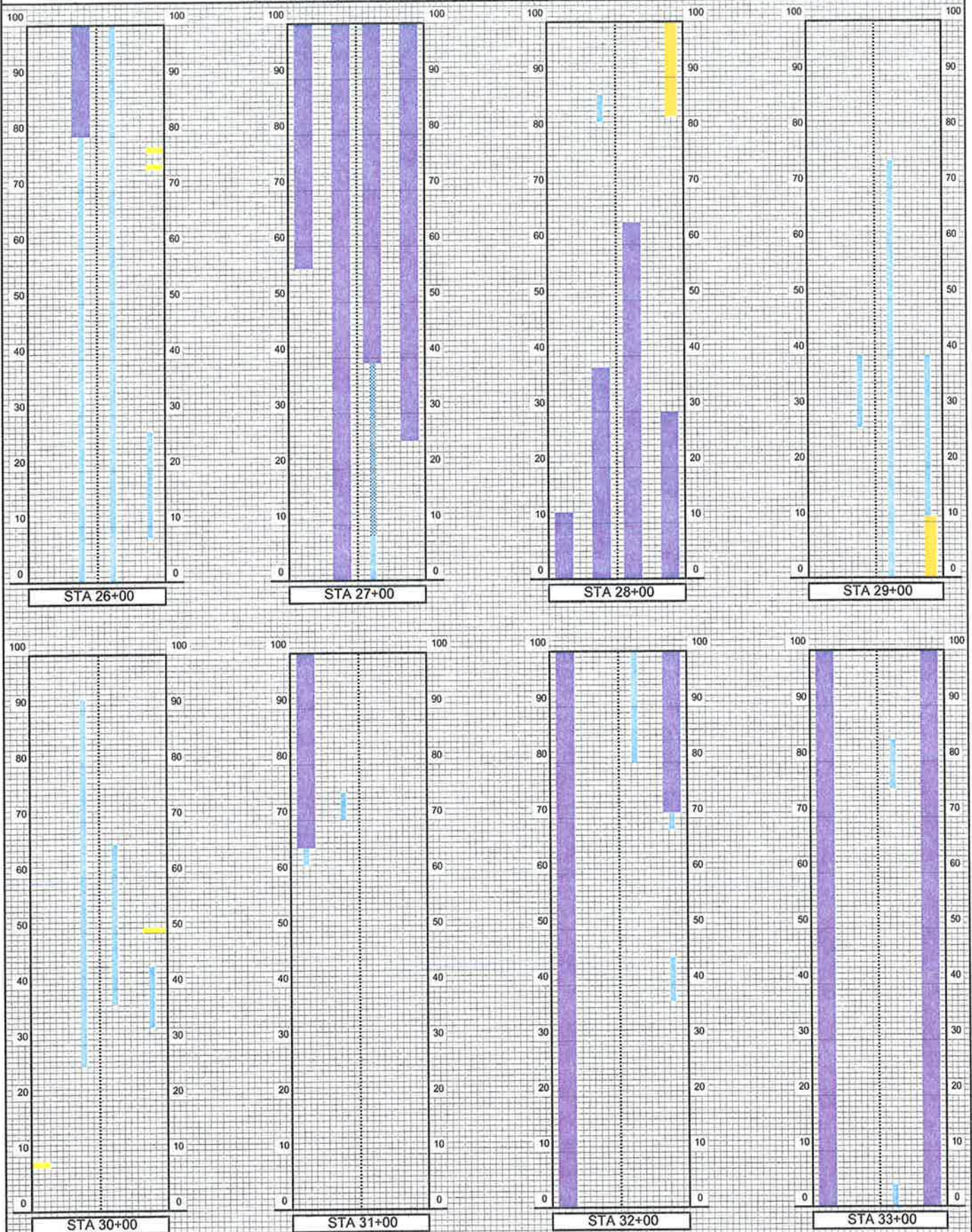


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 1: HMA MIX WITH 15% RAP - STA 10+20 TO 36+50

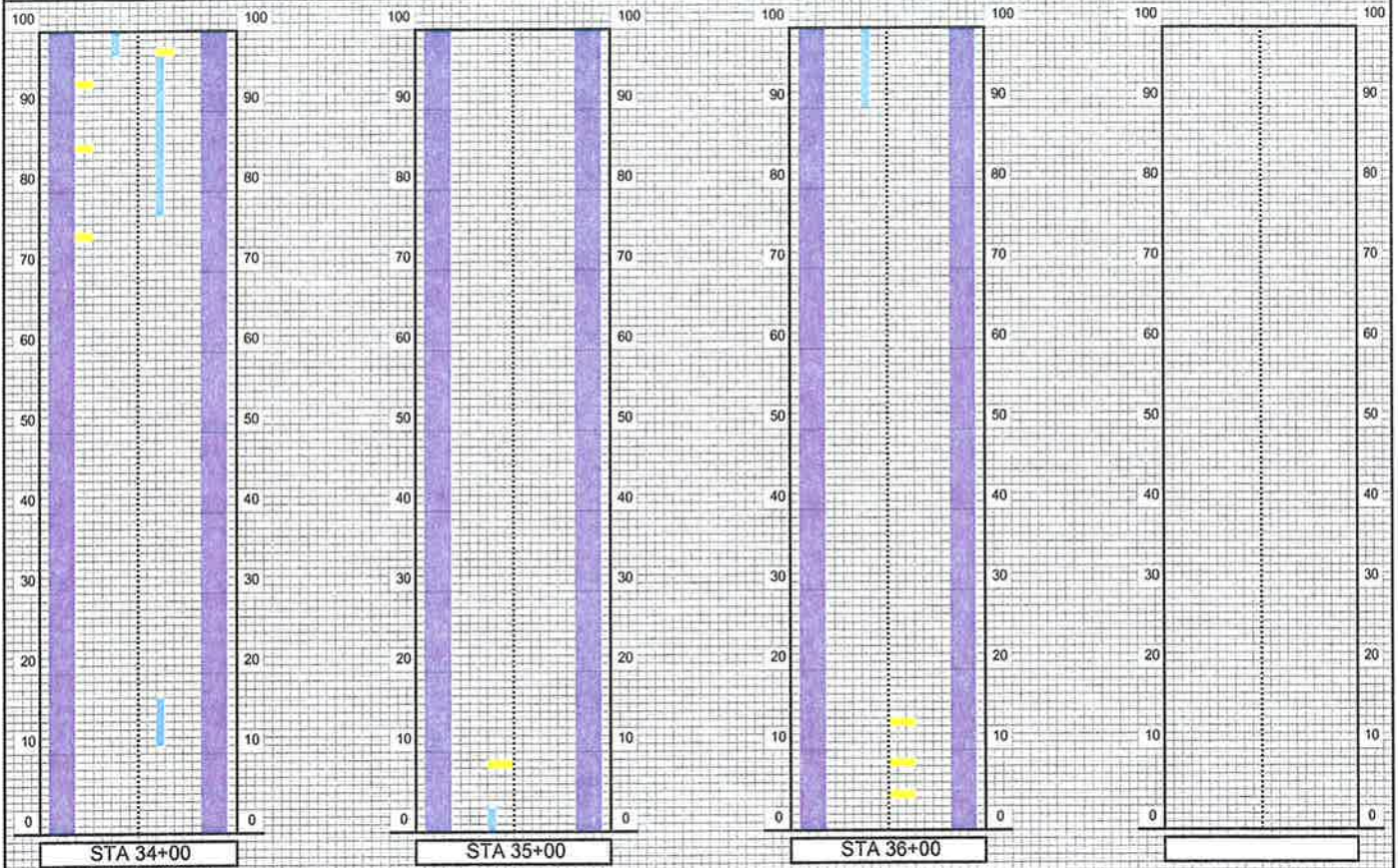


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 1: HMA MIX WITH 15% RAP - STA 10+20 TO 36+50

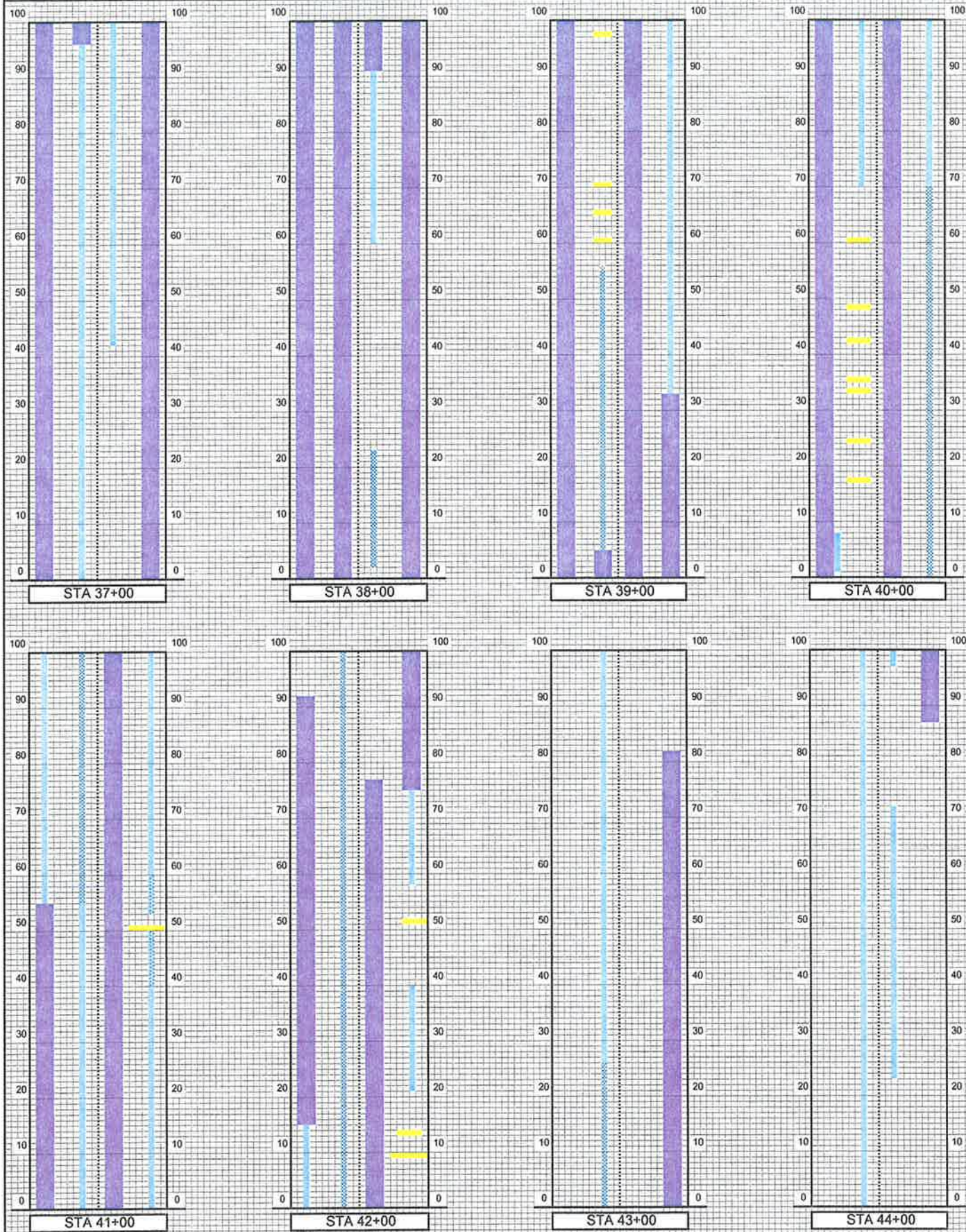


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 2: HMA MIX WITH 3% RAS & 15% RAP - STA 36+50 TO 63+10

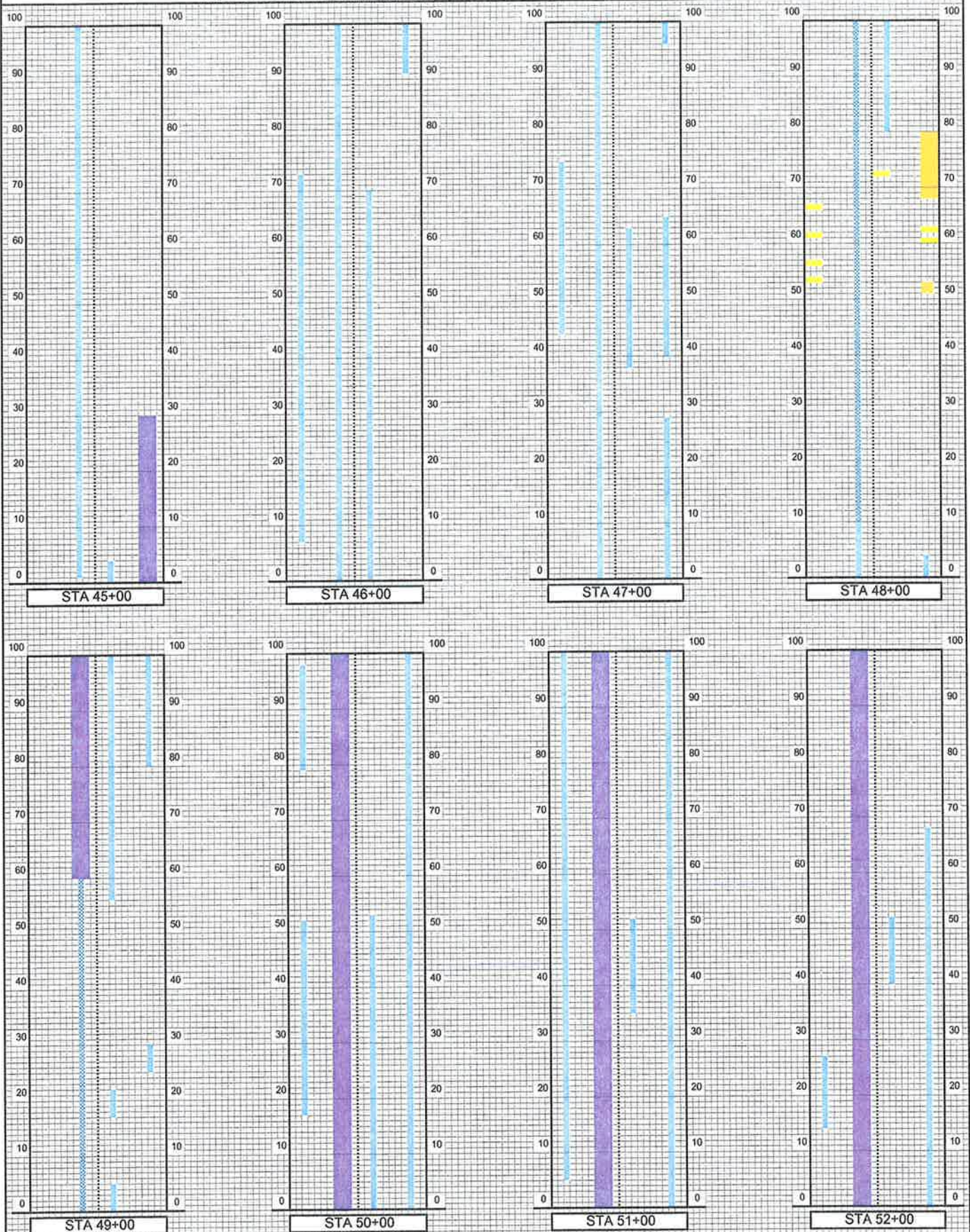


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 2: HMA MIX WITH 3% RAS & 15% RAP - STA 36+50 TO 63+10

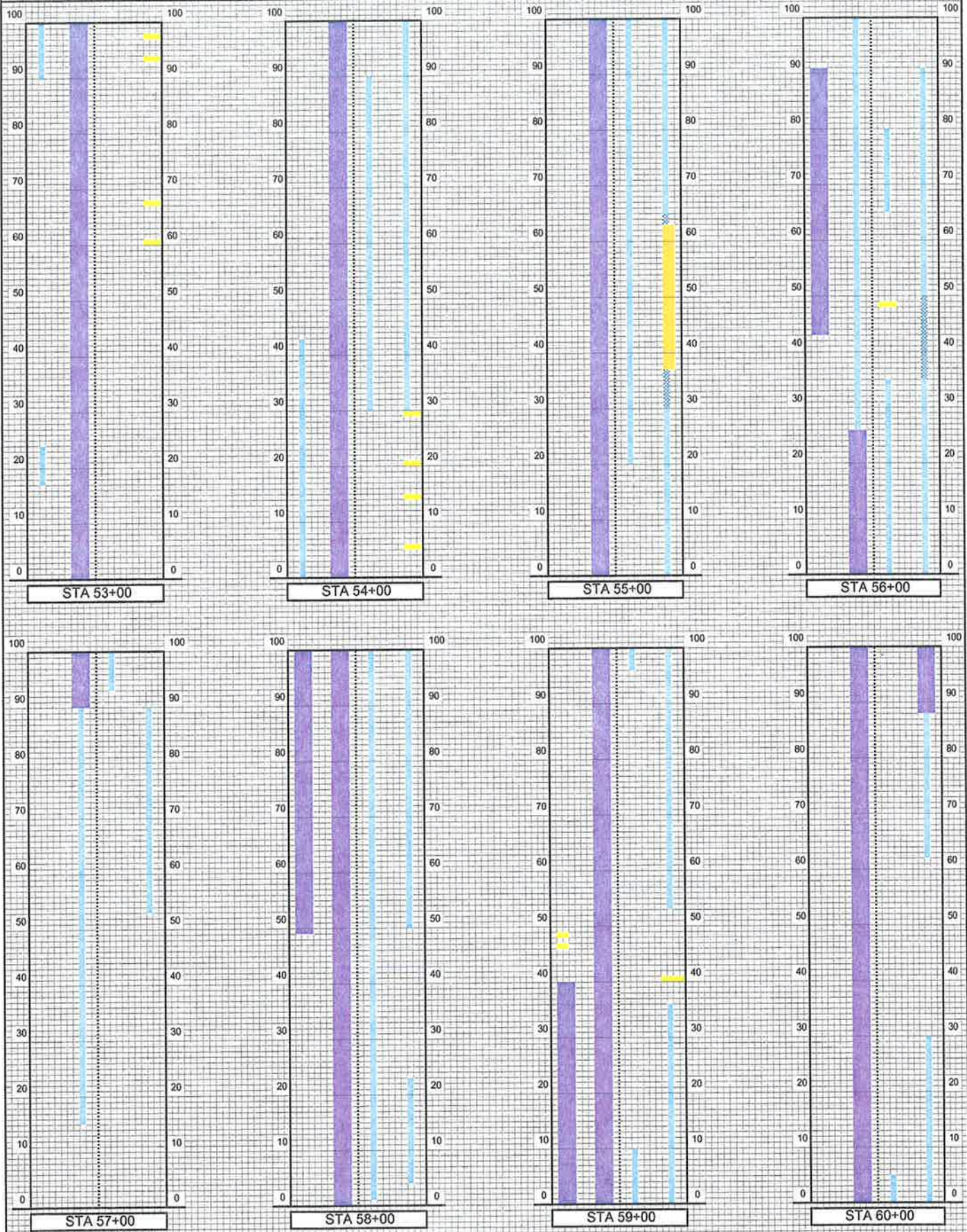


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 2: HMA MIX WITH 3% RAS & 15% RAP - STA 36+50 TO 63+10

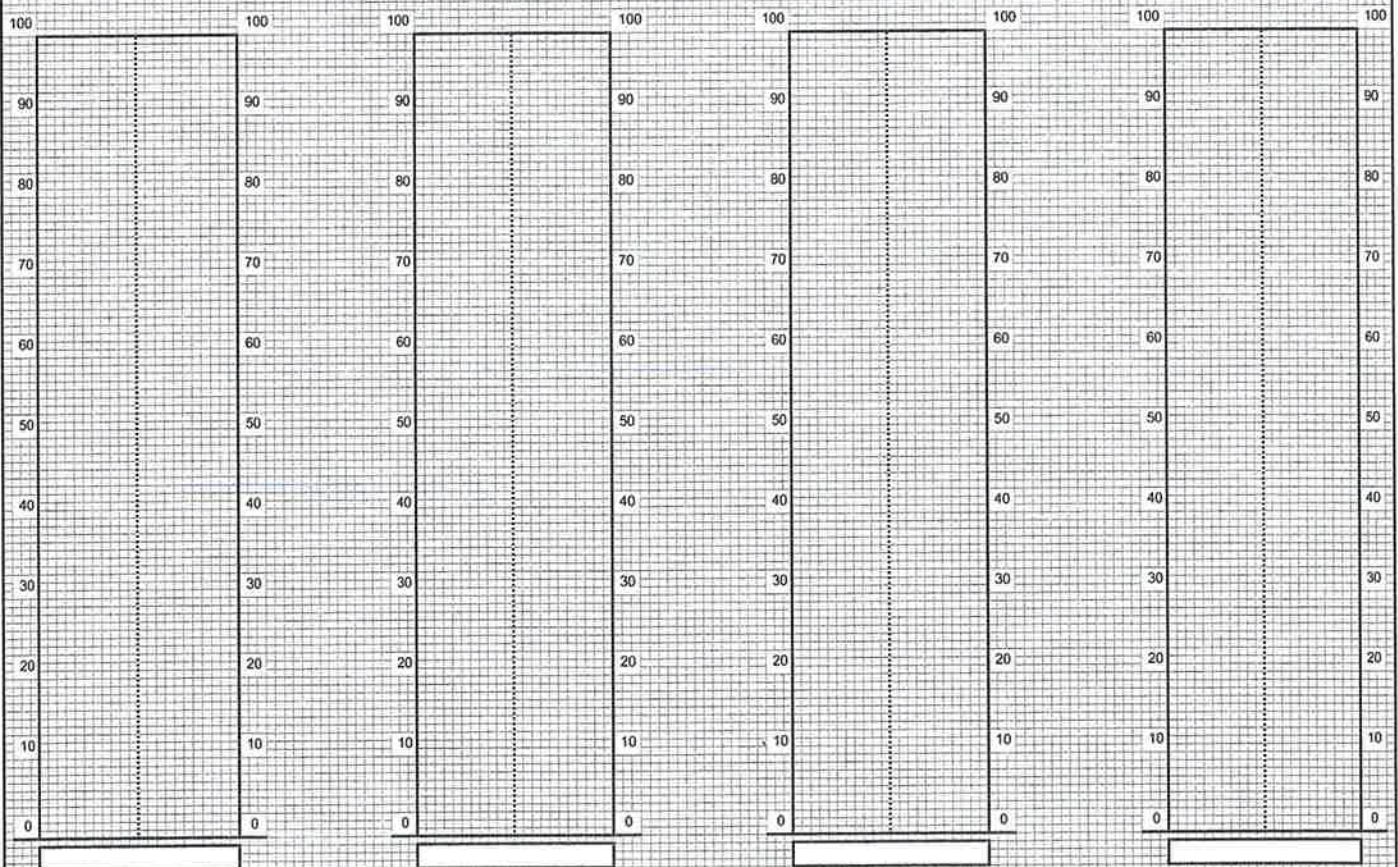


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 2: HMA MIX WITH 3% RAS & 15% RAP - STA 36+50 TO 63+10

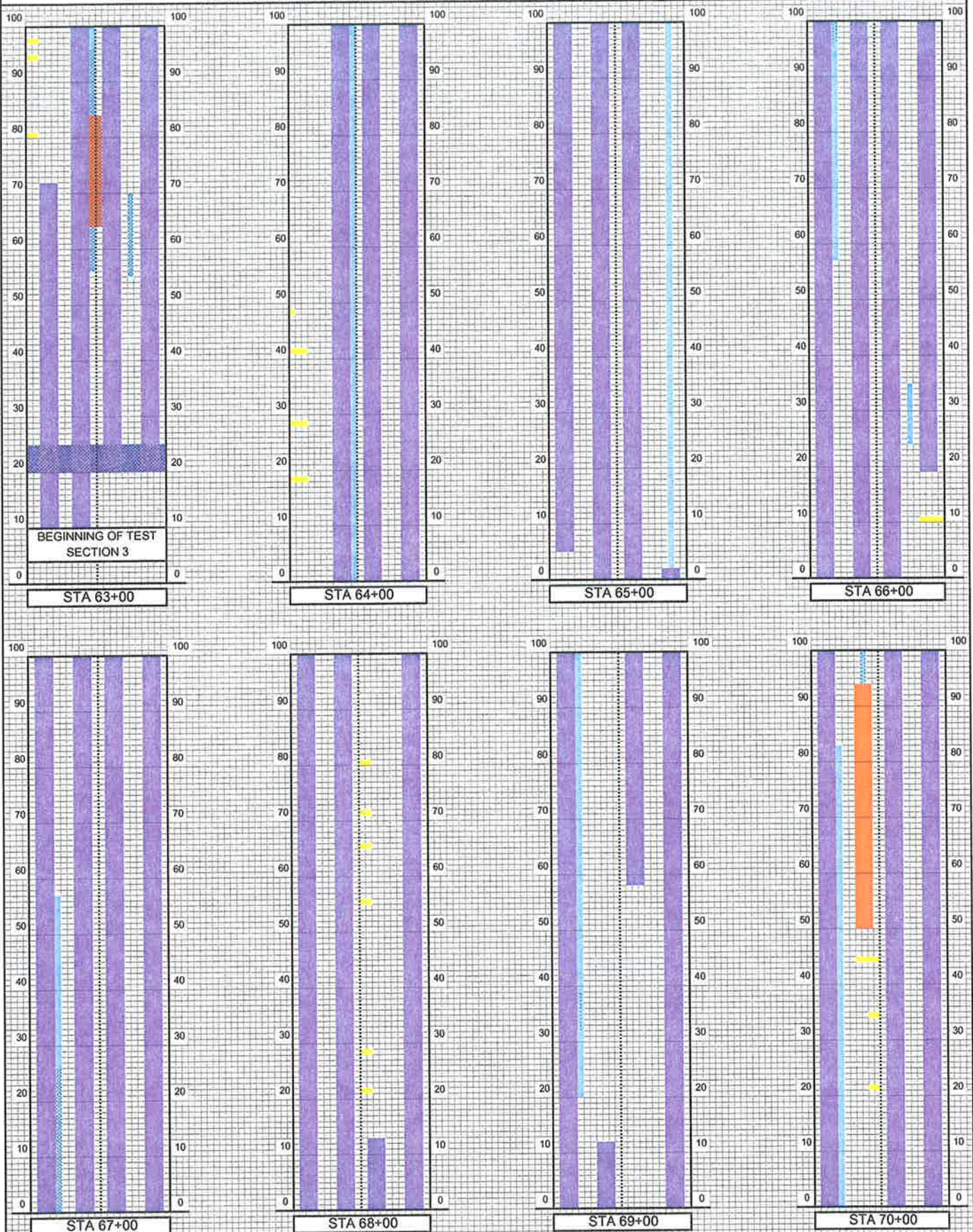


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 3: HMA MIX WITH 3% RAS & 15% RAP - STA 63+10 TO 89+66

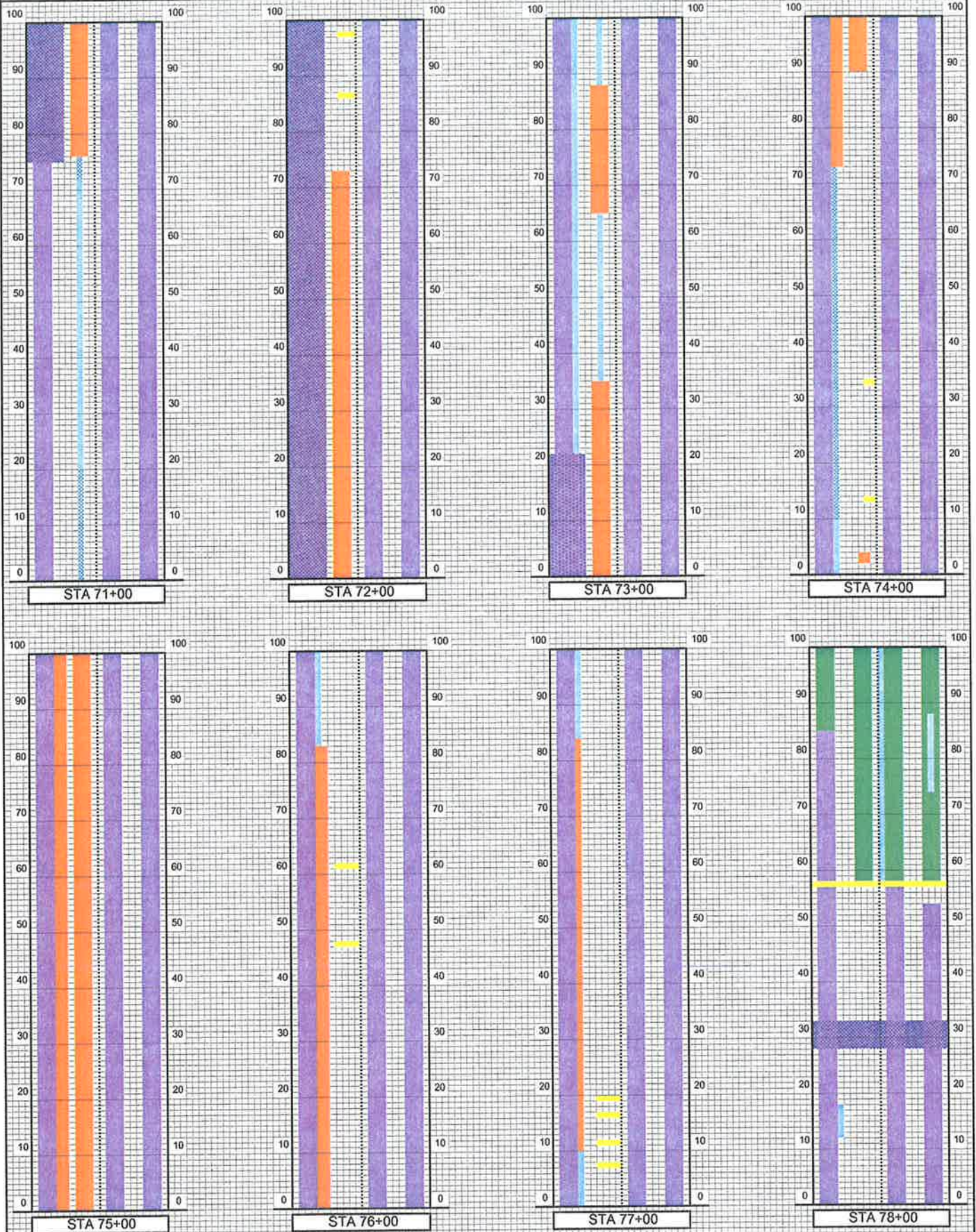


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 3: HMA MIX WITH 3% RAS & 15% RAP - STA 63+10 TO 89+66

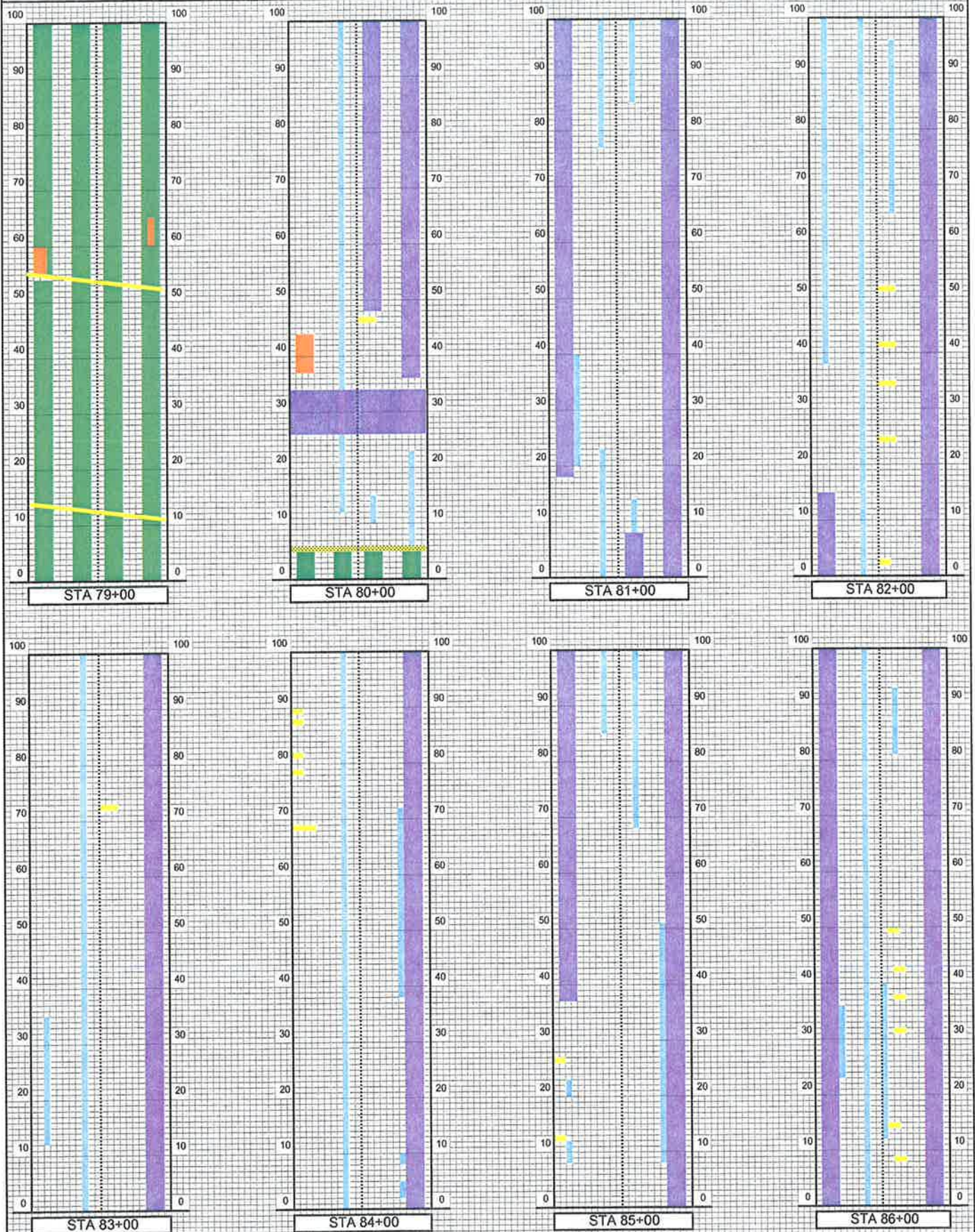


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 3: HMA MIX WITH 3% RAS & 15% RAP - STA 63+10 TO 89+66

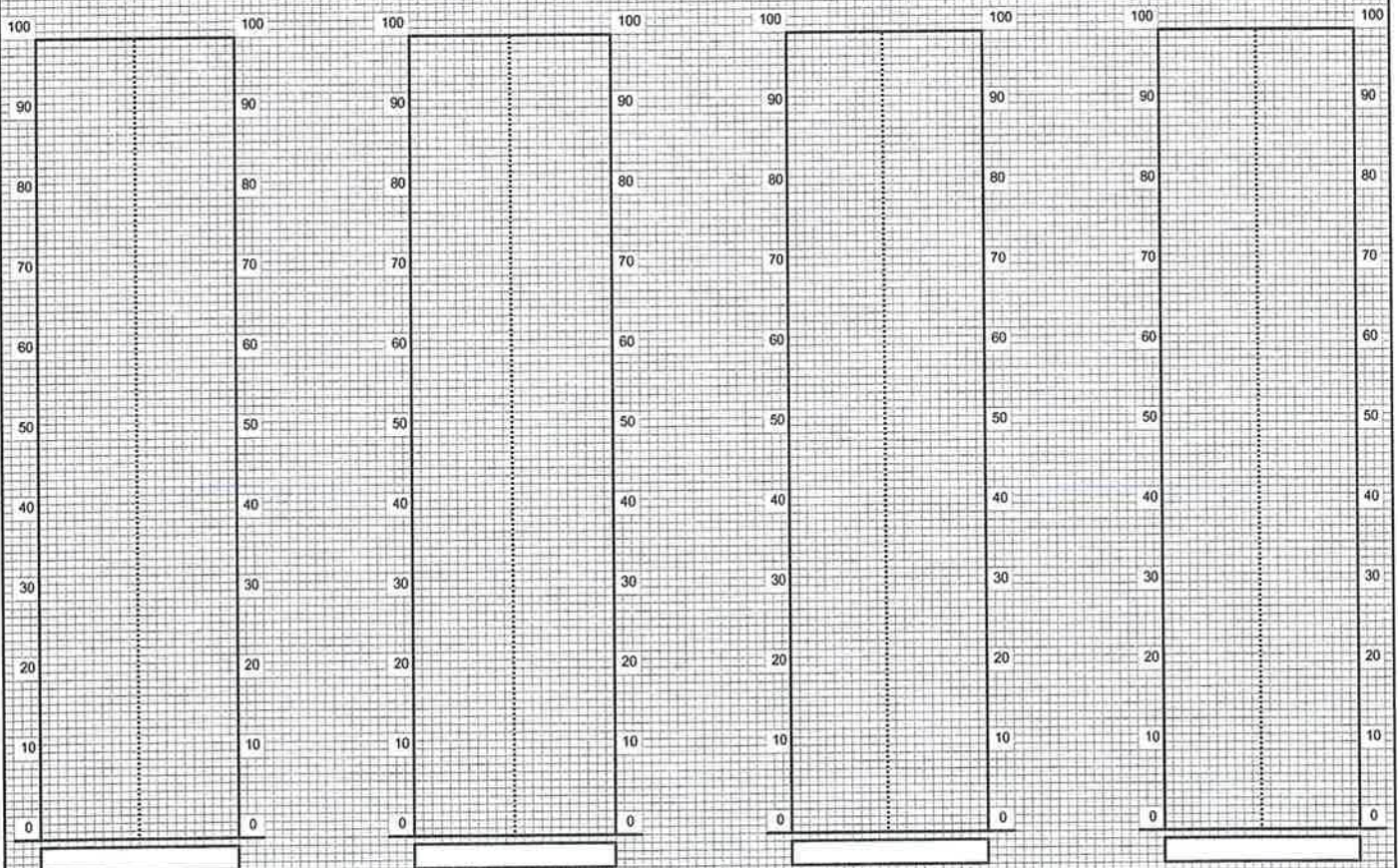


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 3: HMA MIX WITH 3% RAS & 15% RAP - STA 63+10 TO 89+66

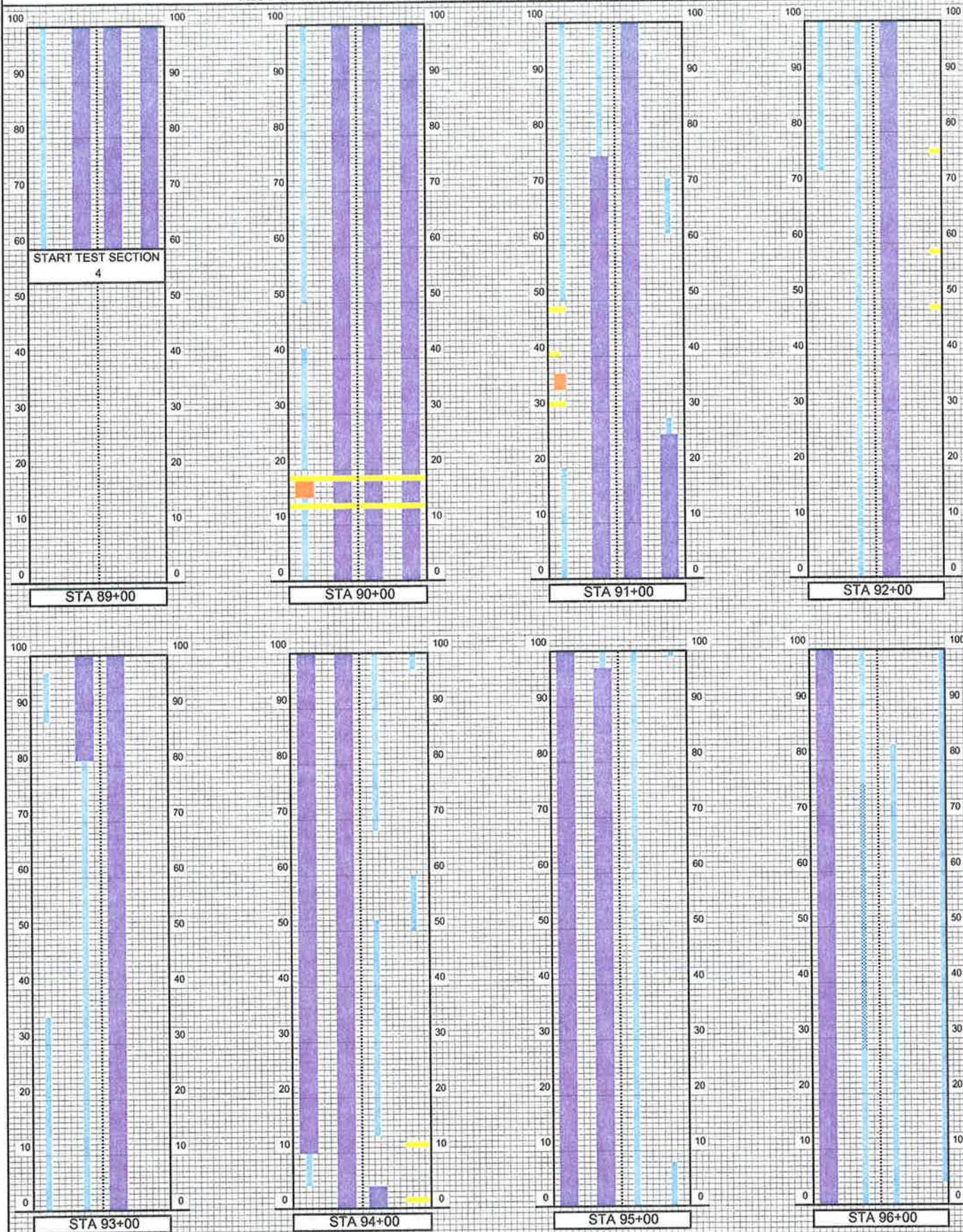


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 4: HMA MIX WITH 15% RAP - STA 89+66 TO 116+00

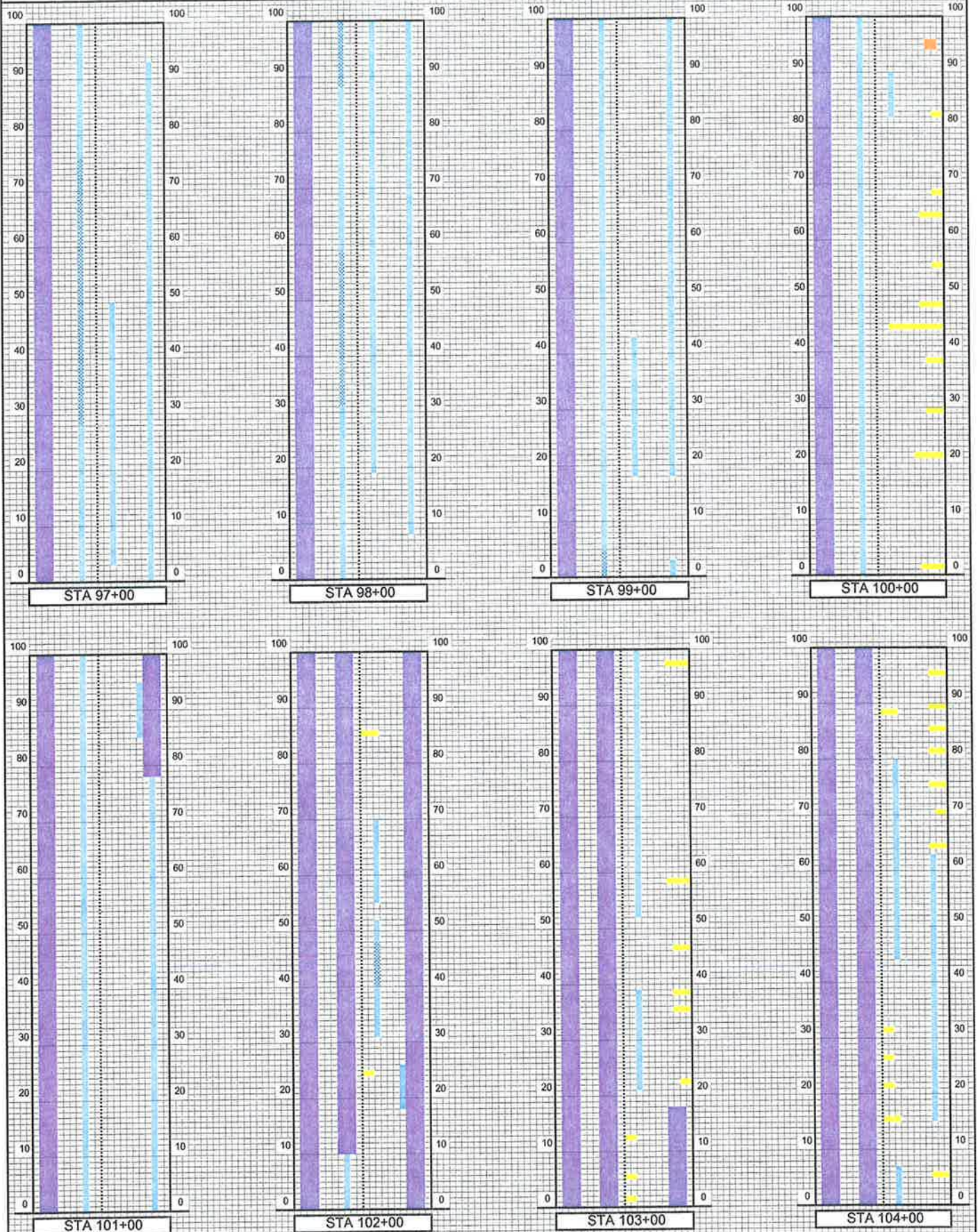


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 4: HMA MIX WITH 15% RAP - STA 89+66 TO 116+00

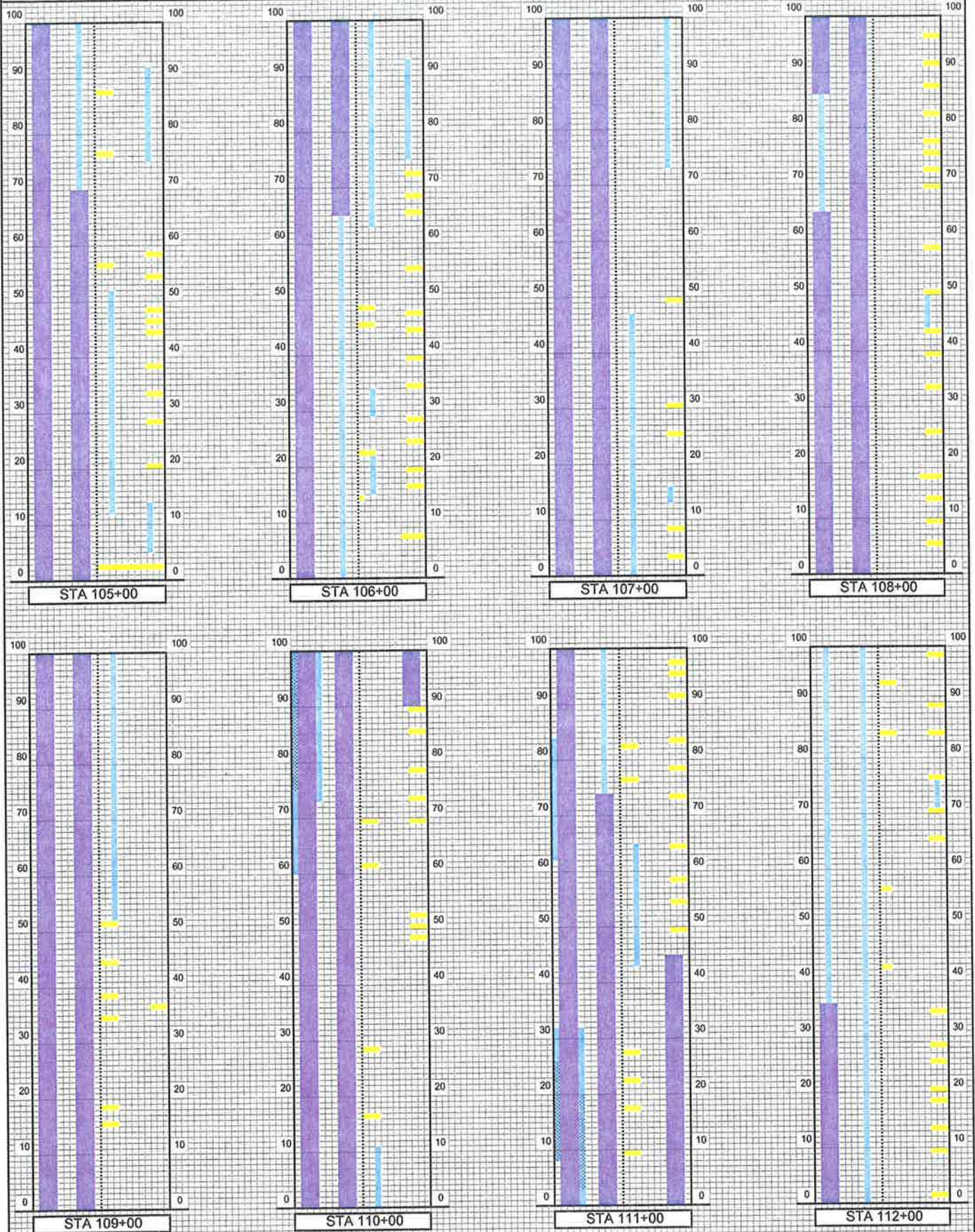


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 4: HMA MIX WITH 15% RAP - STA 89+66 TO 116+00

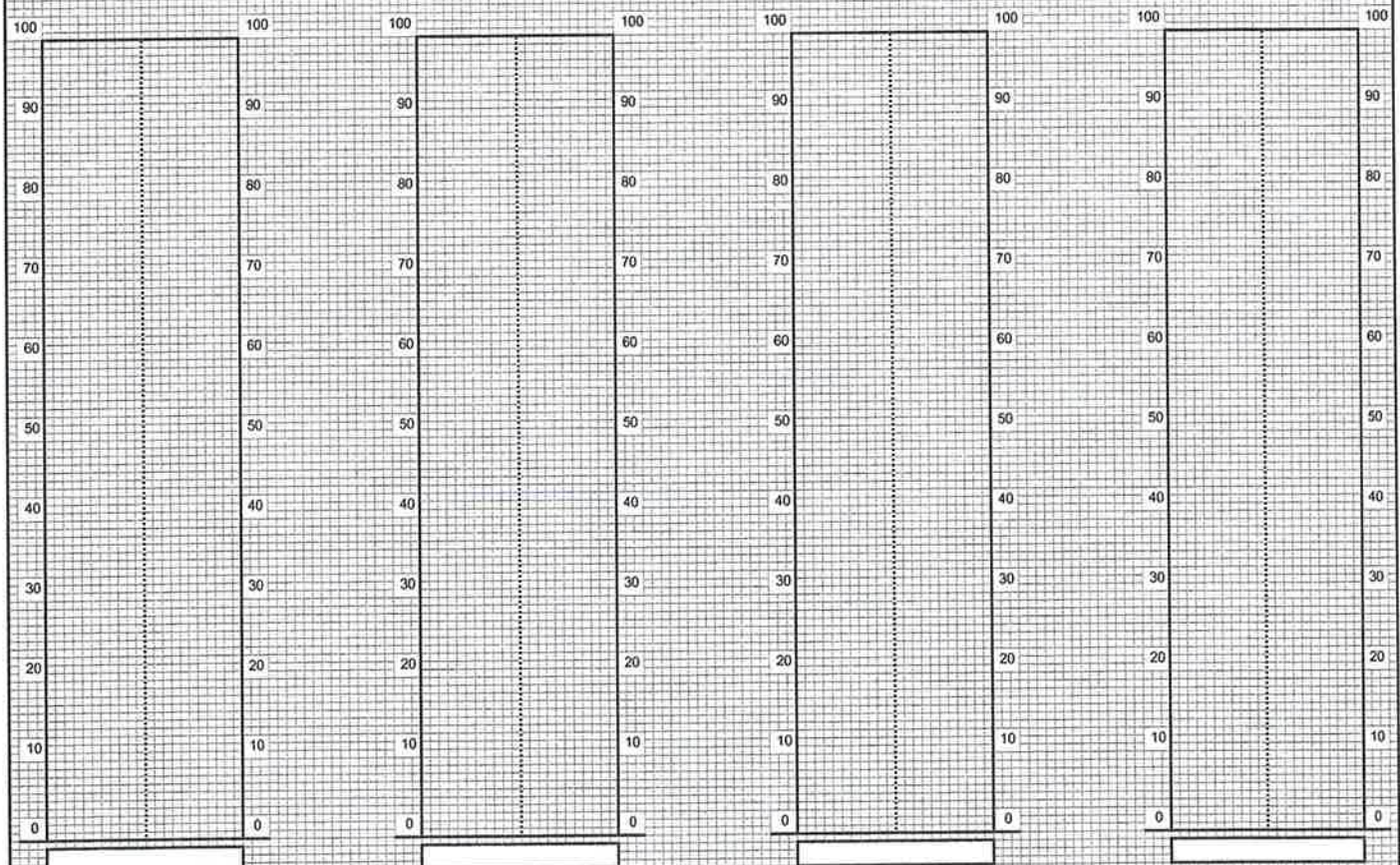
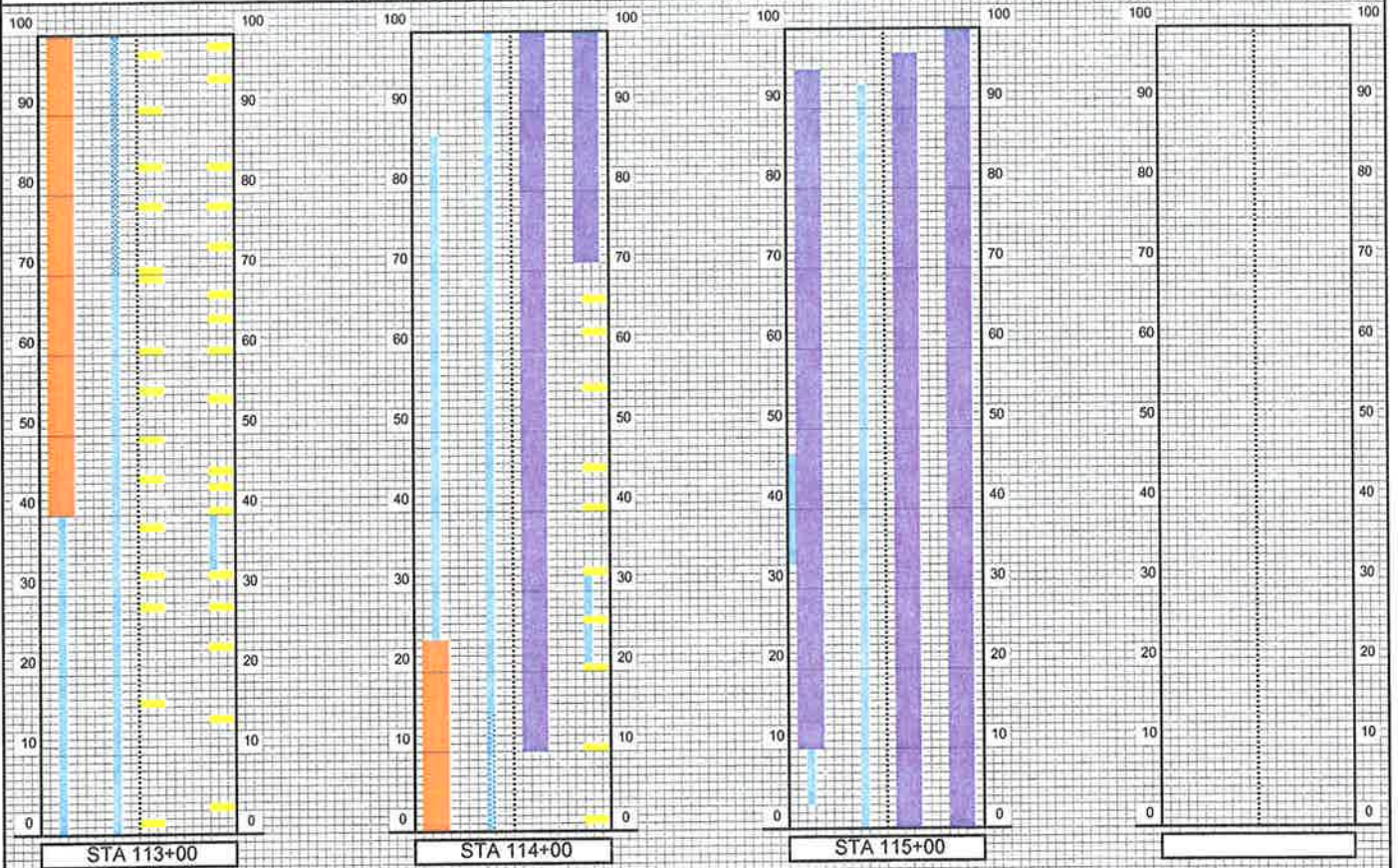


### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# RAS PAVEMENT DEMONSTRATION PROJECT, JOB NO. M78030, TASK 2C2

## TEST SECTION 4: HMA MIX WITH 15% RAP - STA 89+66 TO 116+00



### KEY TO PAVEMENT DISTRESS DESCRIPTIONS

8L	LOW SEVERITY PATCH	5M	MODERATE SEVERITY TRANS. CRACK	2L	LOW SEVERITY ALLIGATOR CRACK
8M	MODERATE SEVERITY PATCH	3L	LOW SEVERITY LONGITUDINAL CRACK	2M	MODERATE SEVERITY ALLIGATOR
5L	LOW SEVERITY TRANSVERSE CRACK	3M	MODERATE SEVERITY LONGIT. CRACK	1M	MODERATE SEVERITY RUTTING

# **APPENDIX B**

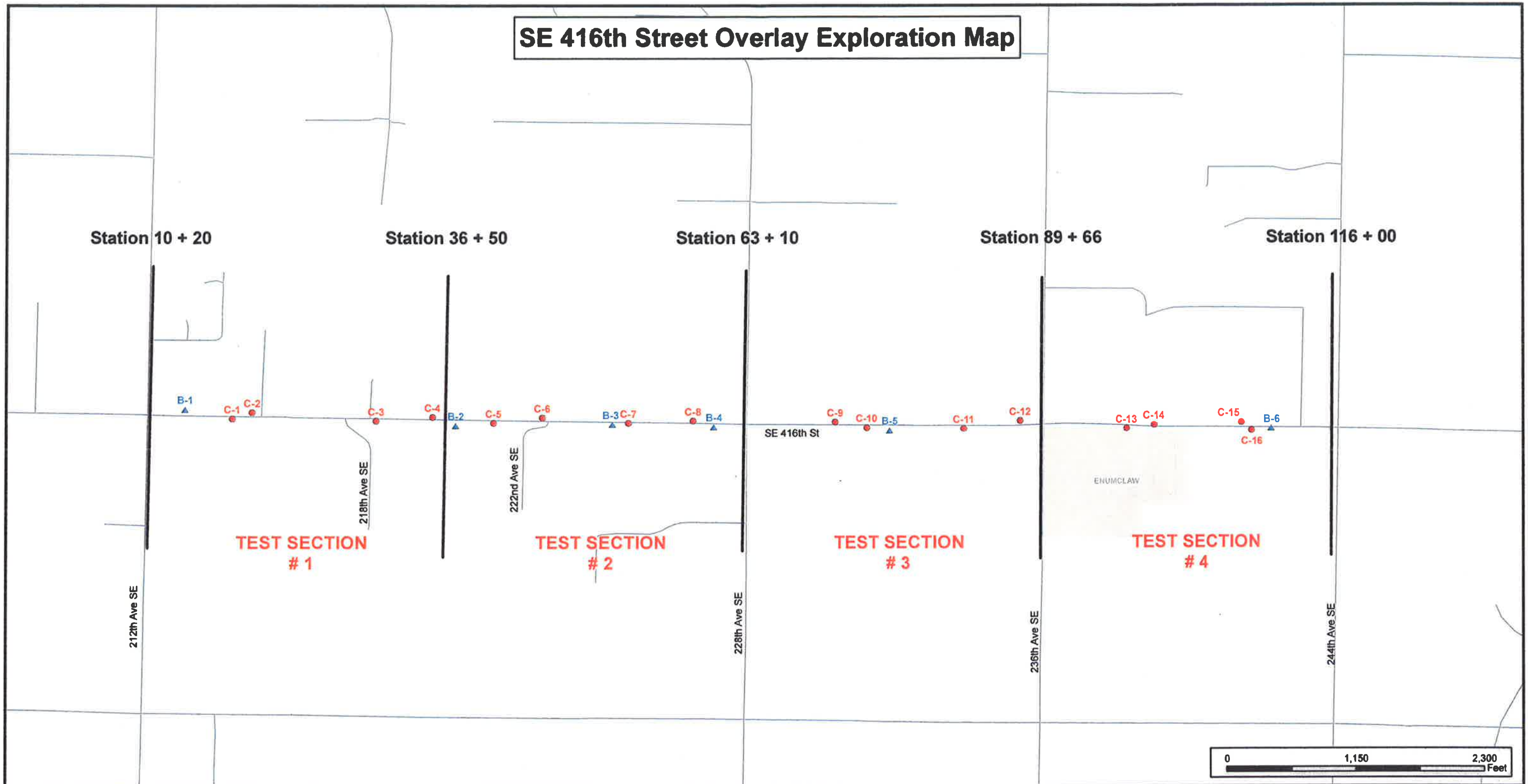
## **SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration Technical Support Document**

**Exploration Map**

**Pavement Core Logs**

**Boring Logs**

# SE 416th Street Overlay Exploration Map



## King County Materials Laboratory

SE 416th Street Overlay  
Shingles in Paving Demonstration

SITE EXPLORATION MAP

- ▲ Approximate Boring Location
- Approximate Core Location
- Station Line
- Street Network
- City



January 7, 2010

File Name:  
KG TUdevelopment\ArcMap\ArcMapProjects\SE\_416th\_St\_exploration\_map.mxd  
Data Sources:  
Standard King County datasets used include: trans\_network, City  
Roads Datasets include: SE416thSt\_stationing, Boring\_Location, Core\_Location

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**King County**

Department of Transportation  
Road Services Division  
Technology Unit



**King County  
Department of Transportation  
Materials Laboratory**

155 Monroe Ave. NE, Bldg D  
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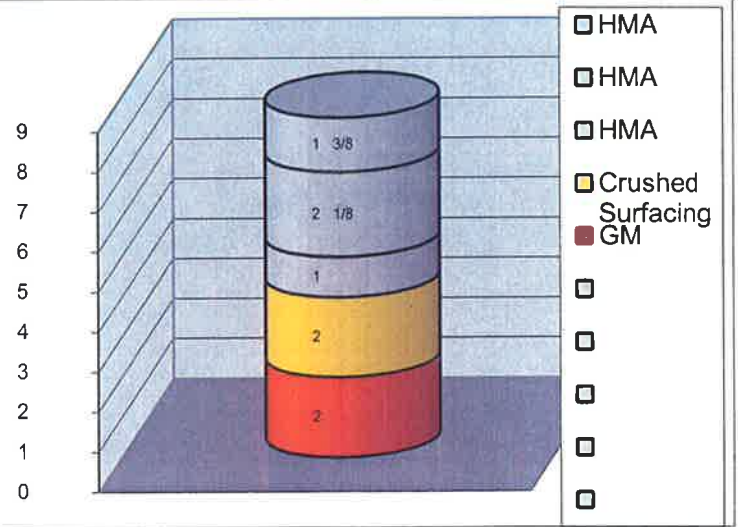
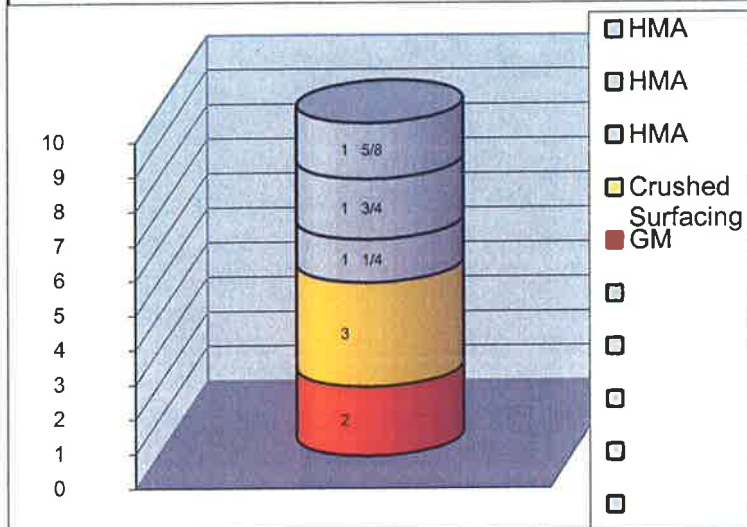
## Pavement Cores

Project: SE 416th Street Overlay: Shingles in Paving Demonstration

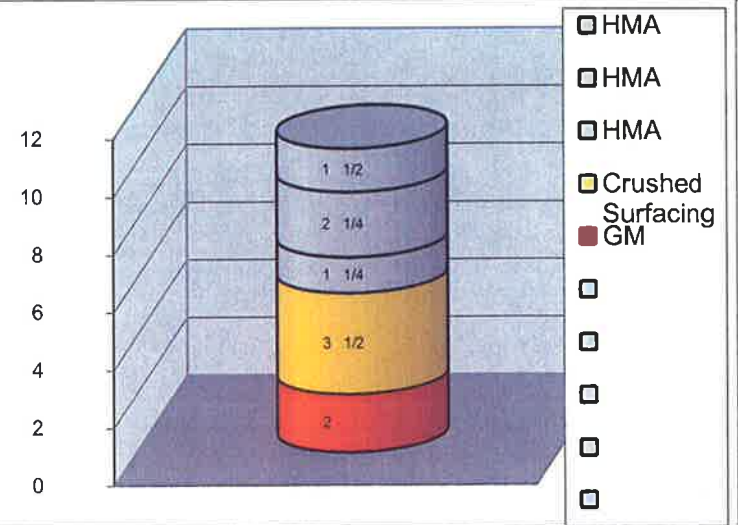
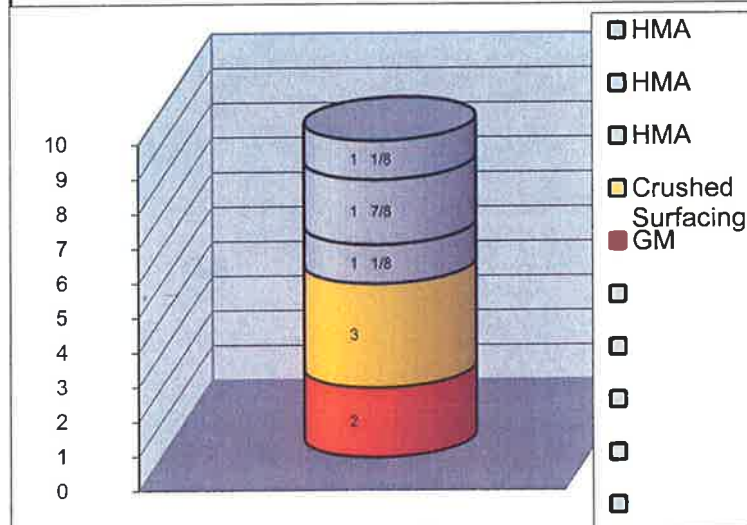
Project Number: M78030

Date of Collection: 5-Aug-09

Core Number: <u>1</u>	Pavement Type: <u>HMA</u>	Core Number: <u>2</u>	Pavement Type: <u>HMA</u>
Station: <u>19+73</u>	Distance to Centerline: <u>5.0' South</u>	Station: <u>22+84</u>	Distance to Centerline: <u>6.5' North</u>
Remarks: <u>Test Section #1, Eastbound Lane.</u>		Remarks: <u>Test Section #1, Westbound Lane.</u>	



Core Number: <u>3</u>	Pavement Type: <u>HMA</u>	Core Number: <u>4</u>	Pavement Type: <u>HMA</u>
Station: <u>28+45</u>	Distance to Centerline: <u>5.5' South</u>	Station: <u>34+70</u>	Distance to Centerline: <u>5.0' North</u>
Remarks: <u>Test Section #1, Eastbound Lane.</u>		Remarks: <u>Test Section #1, Westbound Lane.</u>	





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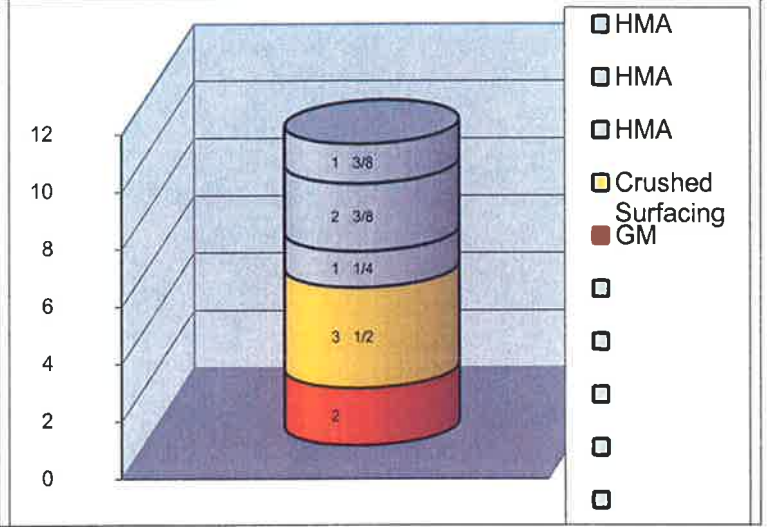
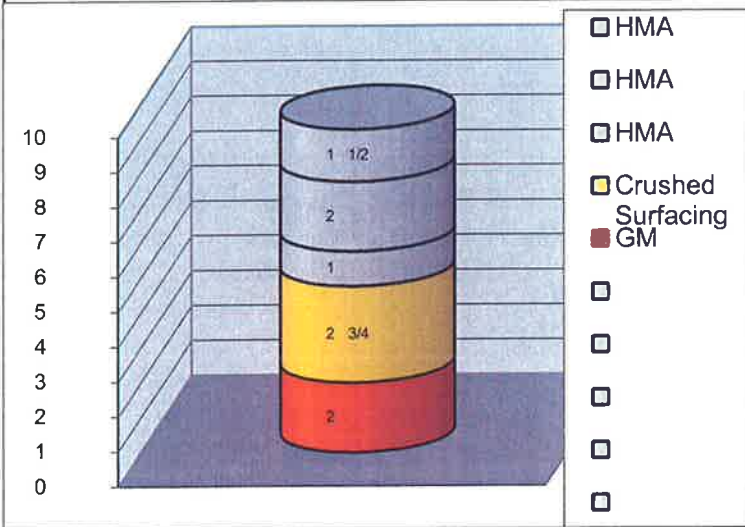
## Pavement Cores

Project: SE 416th Street Overlay: Shingles in Paving Demonstration

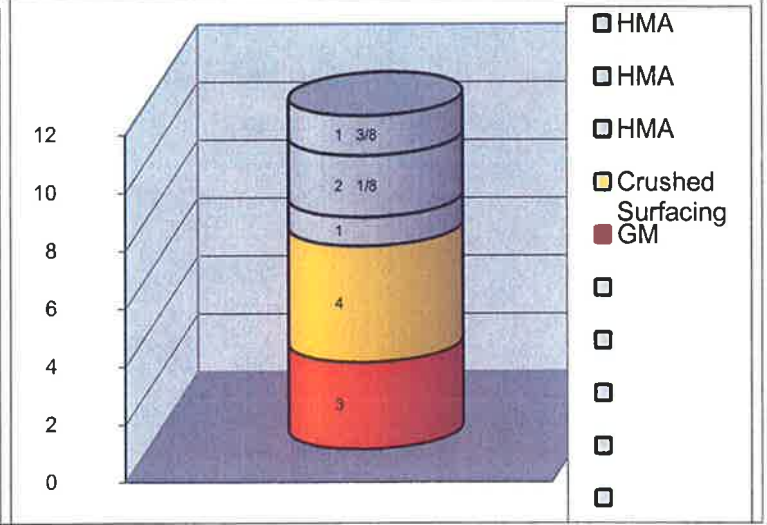
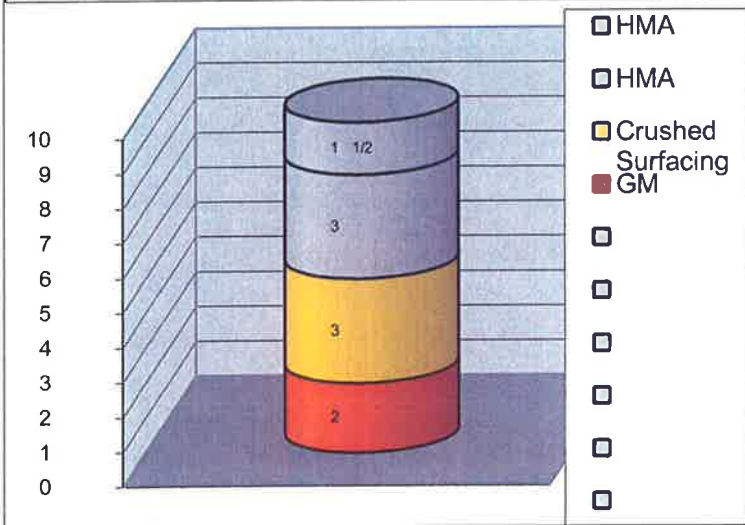
Project Number: M78030

Date of Collection: 5-Aug-09

Core Number: <u>5</u>	Pavement Type: <u>HMA</u>	Core Number: <u>6</u>	Pavement Type: <u>HMA</u>
Station: <u>40+39</u>	Distance to Centerline: <u>5.5' South</u>	Station: <u>46+60</u>	Distance to Centerline: <u>5.5' North</u>
Remarks: <u>Test Section #2, Eastbound Lane.</u>		Remarks: <u>Test Section #2, Westbound Lane.</u>	



Core Number: <u>7</u>	Pavement Type: <u>HMA</u>	Core Number: <u>8</u>	Pavement Type: <u>HMA</u>
Station: <u>51+66</u>	Distance to Centerline: <u>5.5' South</u>	Station: <u>55 +99</u>	Distance to Centerline: <u>6.0' North</u>
Remarks: <u>Test Section #2, Eastbound Lane.</u>		Remarks: <u>Test Section #2, Westbound Lane.</u>	





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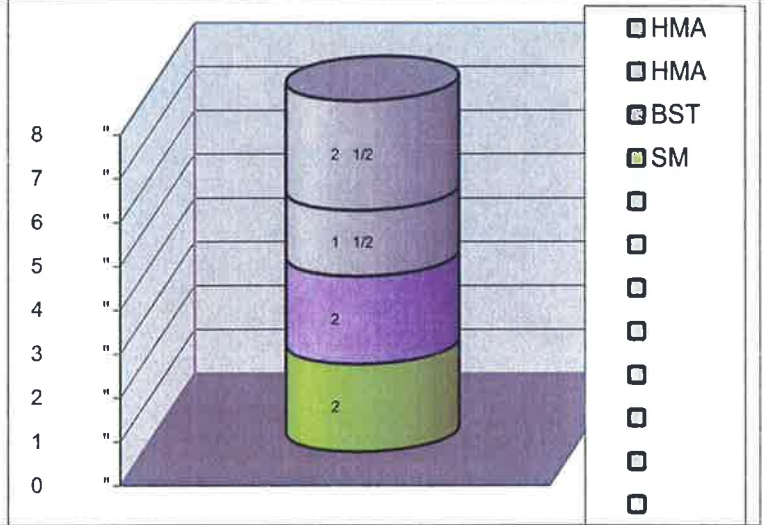
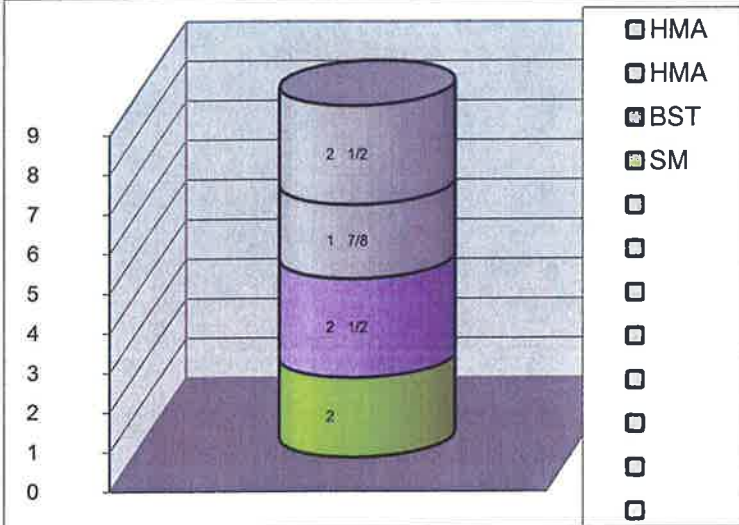
## Pavement Cores

Project: SE 416th Street Overlay: Shingles in Paving Demonstration

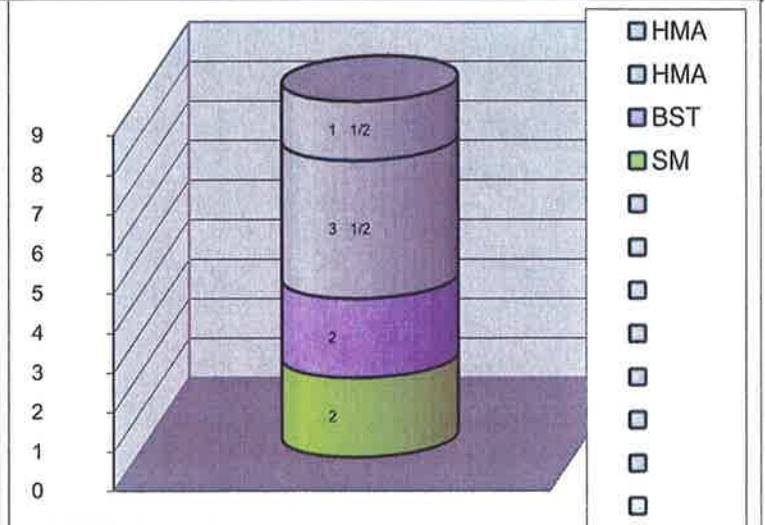
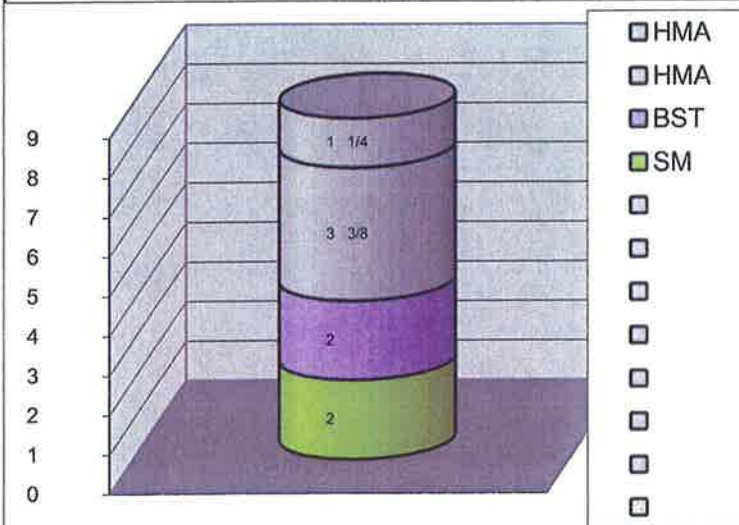
Project Number: M78030

Date of Collection: 5-Aug-09

Core Number: <u>9</u> Pavement Type: <u>HMA</u>	Core Number: <u>10</u> Pavement Type: <u>HMA</u>
Station: <u>68+69</u> Distance to Centerline: <u>6.0' North</u>	Station: <u>73+60</u> Distance to Centerline: <u>7.5' South</u>
Remarks: <u>Test Section #3, Westbound Lane.</u>	Remarks: <u>Test Section #3, Eastbound Lane.</u>
	Cored in recently patched area.



Core Number: <u>11</u> Pavement Type: <u>HMA</u>	Core Number: <u>12</u> Pavement Type: <u>HMA</u>
Station: <u>83+54</u> Distance to Centerline: <u>5.0' South</u>	Station: <u>86+39</u> Distance to Centerline: <u>6.0' North</u>
Remarks: <u>Test Section #3, Eastbound Lane.</u>	Remarks: <u>Test Section #3, Westbound Lane.</u>





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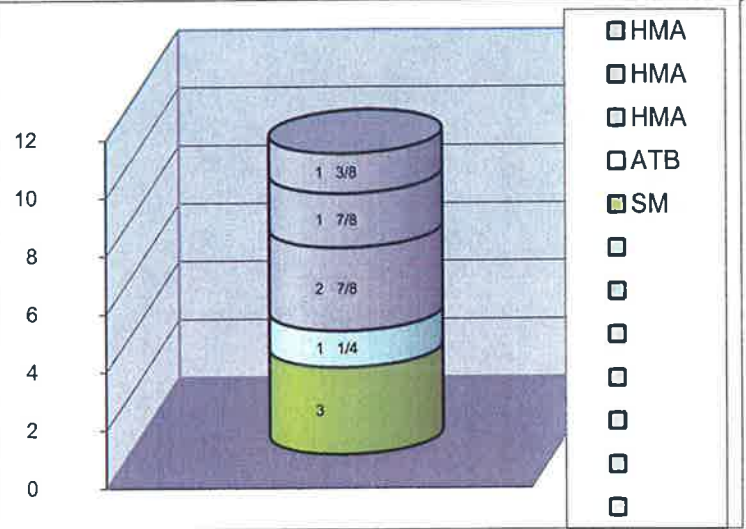
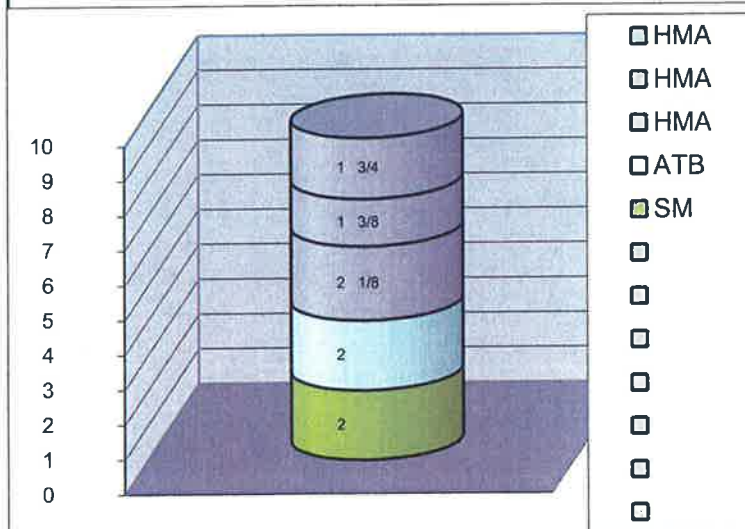
## Pavement Cores

Project: SE 416th Street Overlay: Shingles in Paving Demonstration

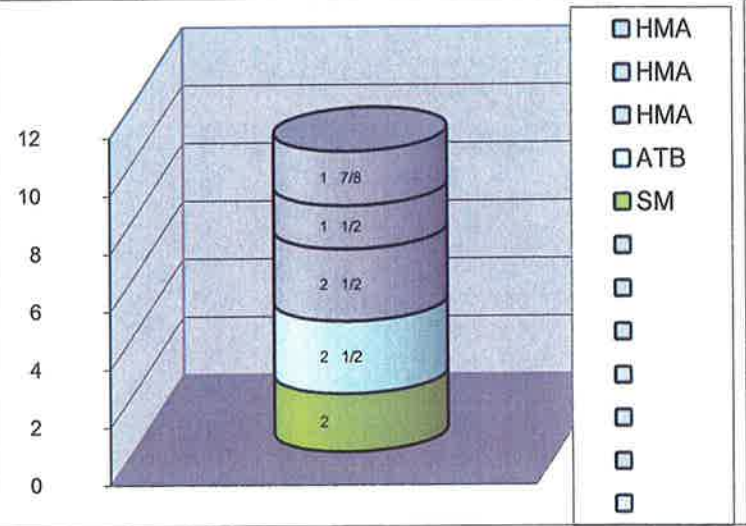
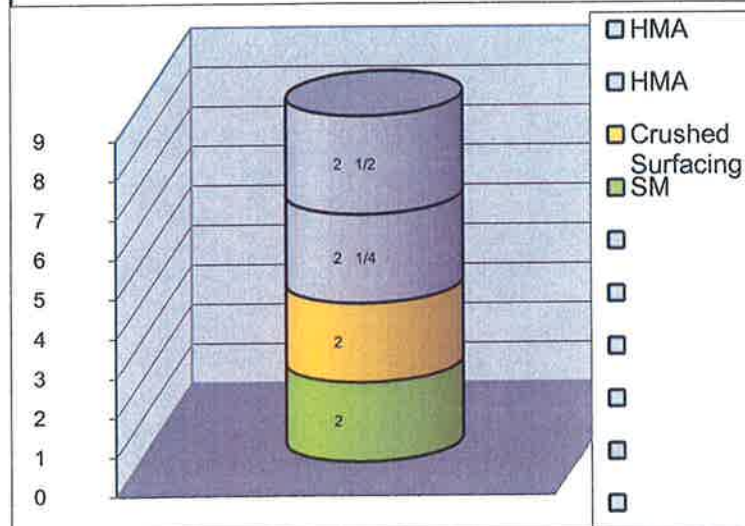
Project Number: M78030

Date of Collection: 5-Aug-09

Core Number: <u>13</u>	Pavement Type: <u>HMA</u>	Core Number: <u>14</u>	Pavement Type: <u>HMA</u>
Station: <u>99+40</u>	Distance to Centerline: <u>6.0' South</u>	Station: <u>100+89</u>	Distance to Centerline: <u>6.0' North</u>
Remarks: <u>Test Section #4, Eastbound Lane.</u>		Remarks: <u>Test Section #4, Westbound Lane.</u>	



Core Number: <u>15</u>	Pavement Type: <u>HMA</u>	Core Number: <u>16</u>	Pavement Type: <u>HMA</u>
Station: <u>108+00</u>	Distance to Centerline: <u>7.5' North</u>	Station: <u>109+80</u>	Distance to Centerline: <u>5.0' South</u>
Remarks: <u>Test Section #4, Westbound Lane.</u>		Remarks: <u>Test Section #4, Eastbound Lane.</u>	
Cored in recently patched area.			




# KING COUNTY BORING LOG

## BORING B-1

**PROJECT:** SE 416th Street Overlay  
**BORING LOCATION:** Station 14+39, 13.5' N. of Centerline  
**DRILL METHOD:** Truck-Mounted Open Flight Auger  
**OPERATOR:** Signal Electric Inc.  
**DEPTH TO - Water:** N/A

**Caving:** N/A

**DATE:** 8-6-09  
**START:** N/A  
**FINISH:** N/A  
**LOGGER:** K. Kelsey  
**DATE CHECKED:** 8-6-09

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0			Crushed surfacing rock, dry, medium dense.			
98 2		GM	Brown silty gravel with sand, moist, medium dense.	10.1	28.8	Nonplastic
96 4		GM	Brown silty gravel with sand, moist, dense.			
94 6						
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately at road grade. The boring was drilled in the north shoulder of the roadway.*

PLATE NUMBER 1


# KING COUNTY BORING LOG

## BORING B-2

**PROJECT:** SE 416th Street Overlay  
**BORING LOCATION:** Station 37+33, 20.0' S. of Centerline  
**DRILL METHOD:** Truck-Mounted Open Flight Auger  
**OPERATOR:** Signal Electric Inc.  
**DEPTH TO - Water:** N/A

**Caving:** N/A

**DATE:** 8-6-09  
**START:** N/A  
**FINISH:** N/A  
**LOGGER:** K. Kelsey  
**DATE CHECKED:** 8-6-09

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0		GM	Gray to brown silty gravel with sand, moist, medium dense.	10.0	21.7	Nonplastic
98 2		GM	Gray to brown silty gravel with sand, moist, dense.			
96 4						
94 6						
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately at road grade. The boring was drilled in the south shoulder of the roadway.*

**PLATE NUMBER 2**

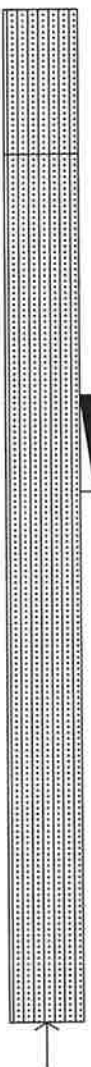
# KING COUNTY BORING LOG

## BORING B-3

PROJECT: **SE 416th Street Overlay**  
 BORING LOCATION: **Station 48+79, 21.0' S. of Centerline**  
 DRILL METHOD: **Truck-Mounted Open Flight Auger**  
 OPERATOR: **Signal Electric Inc.**  
 DEPTH TO - Water: **N/A**

Caving: **N/A**

DATE: **8-6-09**  
 START: **N/A**  
 FINISH: **N/A**  
 LOGGER: **K. Kelsey**  
 DATE CHECKED: **8-6-09**

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0		SM	Brown silty sand with gravel, numerous organics (ditch debris), wet, loose.	18.6	32.6	Nonplastic
98 2		SM	Gray silty sand with gravel, mottled, wet, loose.			
96 4						
94 6						
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately 4 feet below road grade. The boring was drilled in the adjacent storm water ditch, south of the roadway.*

PLATE NUMBER 3

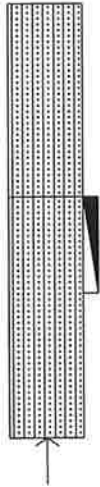
# KING COUNTY BORING LOG

## BORING B-4

**PROJECT:** SE 416th Street Overlay  
**BORING LOCATION:** Station 57+38, 14.5' S. of Centerline  
**DRILL METHOD:** Truck-Mounted Open Flight Auger  
**OPERATOR:** Signal Electric Inc.  
**DEPTH TO - Water:** N/A

**Caving:** N/A

**DATE:** 8-6-09  
**START:** N/A  
**FINISH:** N/A  
**LOGGER:** K. Kelsey  
**DATE CHECKED:** 8-6-09

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0		SM	Gray silty sand with gravel, moist, medium dense.	8.6	34.6	Nonplastic
98 2		SM	Gray silty sand with gravel, moist, dense.			
96 4						
94 6						
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately 0.5 feet below road grade. The boring was drilled in the south shoulder of the roadway.*

**PLATE NUMBER 4**

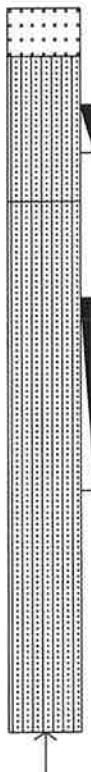
# KING COUNTY BORING LOG

## BORING B-5

**PROJECT:** SE 416th Street Overlay  
**BORING LOCATION:** Station 76+82, 14.5' S. of Centerline  
**DRILL METHOD:** Truck-Mounted Open Flight Auger  
**OPERATOR:** Signal Electric Inc.  
**DEPTH TO - Water:** N/A

**Caving:** N/A

**DATE:** 8-6-09  
**START:** N/A  
**FINISH:** N/A  
**LOGGER:** K. Kelsey  
**DATE CHECKED:** 8-6-09

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0			Crushed surfacing rock.			
		SM	Dark brown silty sand, numerous organics (peat-like), moist, loose.	39.1	26.0	Nonplastic
98 2		SM	Brown silty sand with gravel, mottled, slight iron-staining, moist to wet, loose to medium dense.	13.5	25.4	Liquid Limit (LL)= 23 Plastic Limit (PL)=21
96 4						
94 6						
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately at road grade. The boring was drilled in the south shoulder of the roadway.*

PLATE NUMBER 5

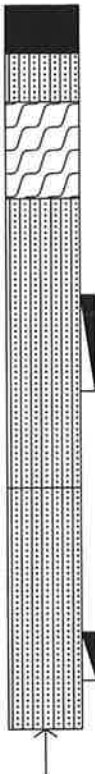
# KING COUNTY BORING LOG

## BORING B-6

**PROJECT:** SE 416th Street Overlay  
**BORING LOCATION:** Station 110+33, 5.5' S. of Centerline  
**DRILL METHOD:** Truck-Mounted Open Flight Auger  
**OPERATOR:** Signal Electric Inc.  
**DEPTH TO - Water:** N/A

**Caving:** N/A

**DATE:** 8-6-09  
**START:** N/A  
**FINISH:** N/A  
**LOGGER:** K. Kelsey  
**DATE CHECKED:** 8-6-09

ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Moist (%)	-200 (%)	Remarks
100 0			0.5 feet Asphalt Concrete Pavement.			Possible oil shot from 0.5' to 1.0' below grade.
		SM	Gray silty gravel with sand, intermixed with possible oil shot, moist, very dense.			
		OL				
98 2		SM	Dark brown organic silt, scattered wood fragments, moist, loose.			Nonplastic
			Gray silty sand with gravel, moist to wet, loose to medium dense.	17.9	33.0	
96 4						
		SM	Gray to brown silty sand with gravel, mottled, slightly iron-stained, wet, loose.			Nonplastic
94 6				18.4	24.5	
92 8						
90 10						
88 12						
86 14						

*No groundwater was encountered during drilling. Surface elevation of borehole is approximately at road grade. The boring was drilled in the eastbound lane of the roadway.*

PLATE NUMBER 6

# KEY TO SYMBOLS

Symbol Description

## Strata symbols



Crushed surfacing rock



Silty gravel



Silty sand



Paving



Low plasticity  
organic silts

## Misc. Symbols



End of boring

## Soil Samplers



Bulk/Grab sample

## Notes:

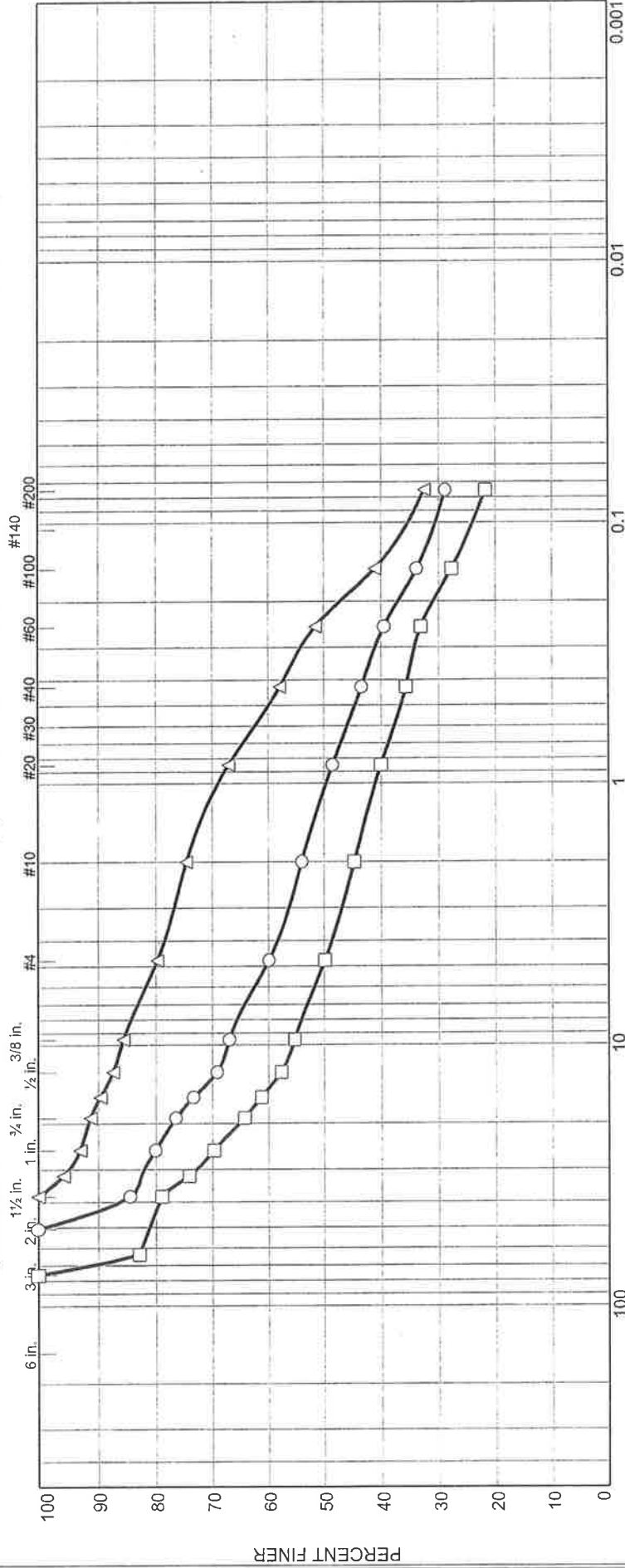
1. Exploratory borings were drilled on 8-6-09 using a track-mounted 12-inch diameter open flight auger.
2. Boring locations were taped in the field. Elevations were assumed at 100 feet for drafting purposes only.
3. These logs are subject to the limitations, conclusions, and recommendations in this report.

# Particle Size Distribution Report

HYDROMETER

U.S. STANDARD SIEVE NUMBERS

U.S. SIEVE OPENING IN INCHES



GRAIN SIZE - mm.

% +3"		% Gravel		% Sand		% Fines	
Coarse	Fine	Coarse	Fine	Coarse	Medium	Fine	Clay
0.0	23.5	16.6	14.6	5.9	10.6	14.6	28.8
0.0	35.7	14.4	14.1	5.2	8.9	14.1	21.7
0.0	8.7	11.5	25.3	5.2	16.7	32.6	
Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description		
B-1	KC-09-909	2.0	8/12/09	GM	Silty gravel with sand		
B-2	KC-09-910	2.0	8/12/09	GM	Silty gravel with sand		
B-3	KC-09-911	4.0	8/12/09	SM	Silty sand with gravel		
				NM %	LL	PL	
				10.1	NV	NP	
				10.0	NV	NP	
				18.6	NV	NP	

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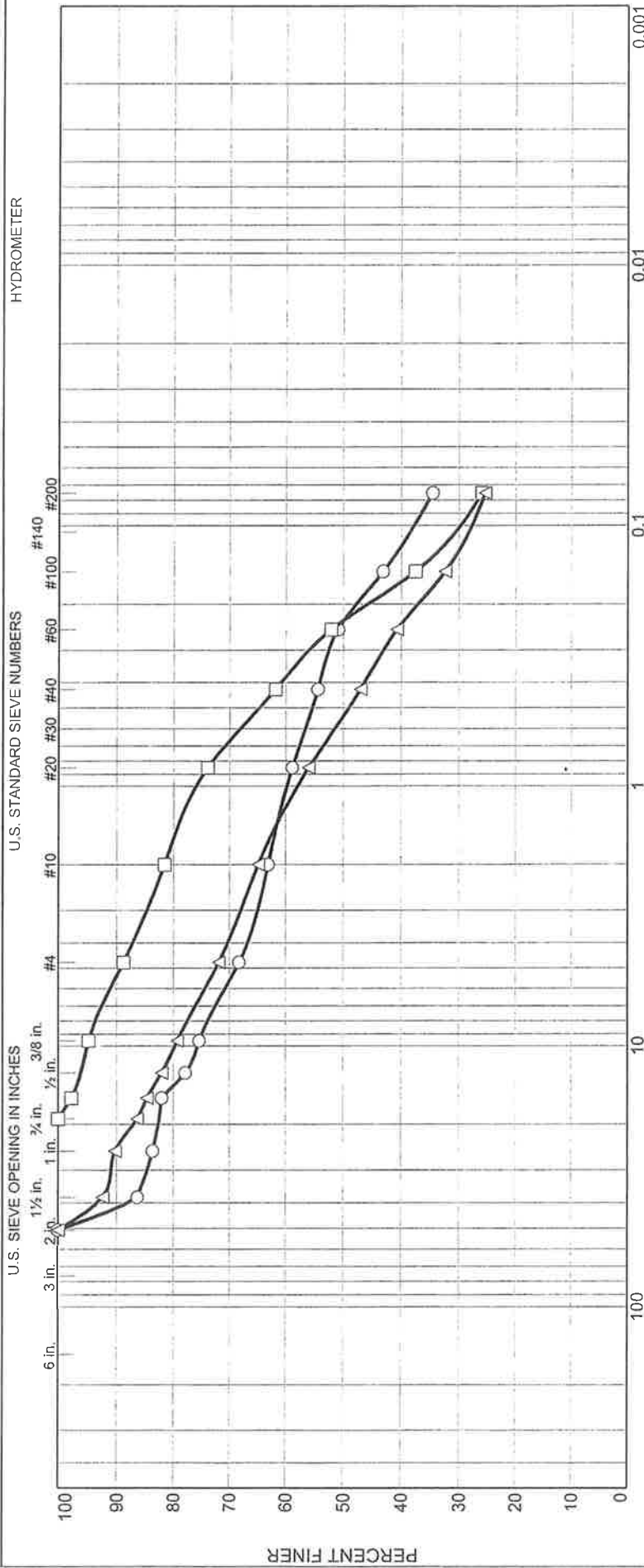
Client King County  
Project SE 416th Street Overlay

MATERIALS LABORATORY

Project No. M78030 Figure

Tested By: vw

# Particle Size Distribution Report



% +3"		% Gravel		% Sand		% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Clay
○	0.0	17.5	14.2	5.2	8.7	19.8	34.6
□	0.0	0.0	11.2	7.2	19.8	35.8	26.0
△	0.0	13.6	14.5	7.0	17.8	21.7	25.4
Source	Sample #	Depth/Elev.	Date Sampled	USCS		Material Description	
○	B-4	KC-09-912	8/12/09	SM	SM	Silty sand with gravel	
□	B-5	KC-09-913	8/12/09	SM	SM	Silty sand	
△	B-5	KC-09-914	8/12/09	SM	SM	Silty sand with gravel	
				NM %	LL	PL	
				8.6	NV	NP	
				39.1	NV	NP	
				13.5	23	21	

Client King County		KING COUNTY	
Project SE 416th Street Overlay			
Project No. M78030		MATERIALS LABORATORY	
		Figure	

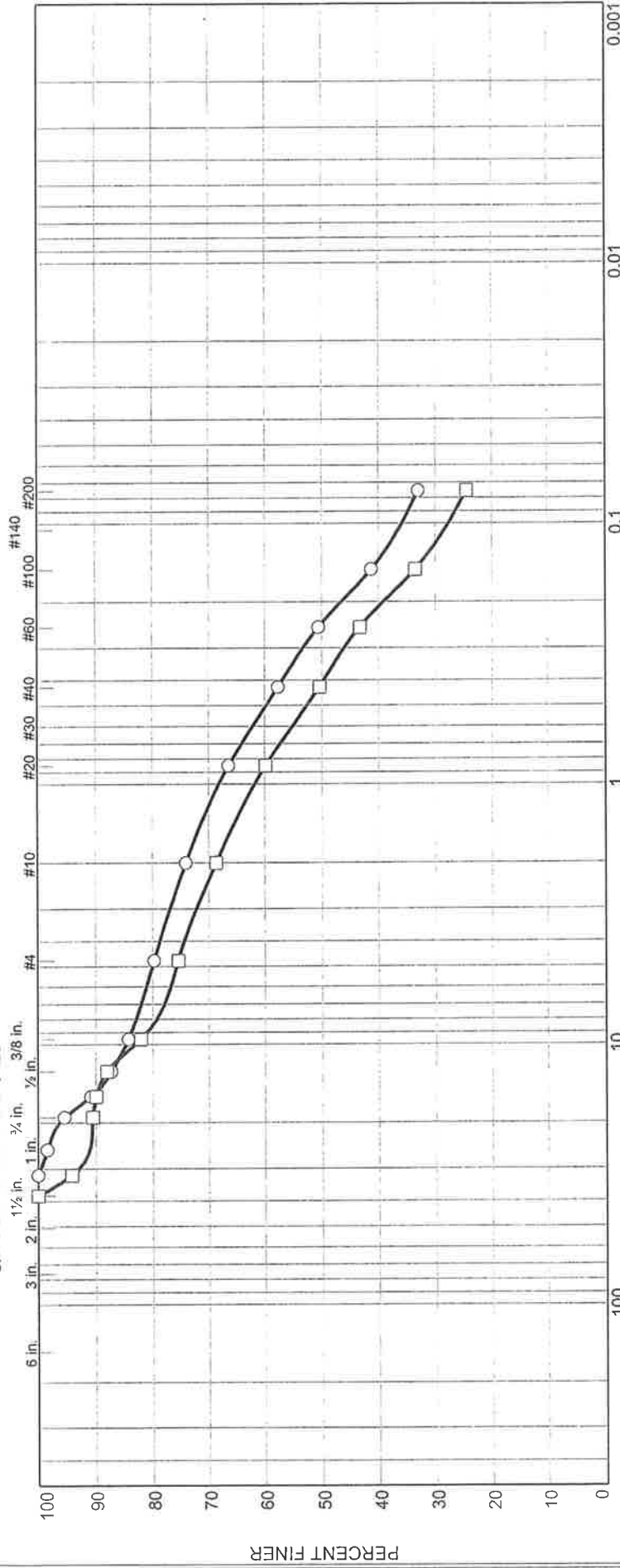
Tested By: vw

# Particle Size Distribution Report

HYDROMETER

U.S. STANDARD SIEVE NUMBERS

U.S. SIEVE OPENING IN INCHES



GRAIN SIZE - mm.

% +3"		% Gravel		% Sand		% Fines	
Coarse	Fine	Coarse	Fine	Medium	Fine	Silt	Clay
4.6	15.6	5.8	24.7	16.3	33.0		
9.5	15.0	6.8	25.9	18.3	24.5		

Source	Sample #	Depth/Elev.	Date Sampled	USCS	Material Description	NM %	LL	PL
B-6	KC-09-915	3.0	8/12/09	SM	Silty sand with gravel	17.9	NV	NP
B-6	KC-09-916	6.5	8/12/09	SM	Silty sand with gravel	18.4	NV	NP

KING COUNTY

Client King County

Project SE 416th Street Overlay

MATERIALS LABORATORY

Project No. M78030

Figure

Tested By: vw

# **APPENDIX C**

## **SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration Technical Support Document**

### **Pre-Construction Falling Weight Deflectometer Test Data**

**SE 416<sup>th</sup> Street Overlay: Shingles in Paving  
Demonstration**

**Pre-Construction Falling Weight Deflectometer Data**

**Eastbound Lane**

# FWD - Non Destructive Pavement Testing

**Route: SE 416th Street**

**Section: 212th Ave SE to 244th Ave SE (EB Lane)**

NOTE: Summary values are adjusted to 9,000 pounds load and adjusted for pavement thickness and temperature. Modulus determination is based on the deflection 48 in From Load.

FWD File = G:\Pavement\FWD-TEST\King County\FWD\Before\SE  
416th St - RAS Study EBN.FWD

Date Tested = 08/05/09

Thickness = Thick AC (> 4 in)

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 1100</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16563.0	34.70	25.80	19.33	7.85	3.83	2.74
Drop 2	12389.0	28.40	20.91	15.67	6.15	2.99	2.07
Drop 3	9059.0	22.25	16.35	12.17	4.60	2.19	1.48
Drop 4	6058.0	15.23	11.15	8.24	2.94	1.39	0.92
Normalized	9000.0	22.11	16.25	12.09	4.57	2.17	1.47
<b>Adjusted Deflection = 26.03 mils</b>		<b>Area = 16.7 in</b>		<b>Modulus = 34.540 ksi</b>			
<b>Station = 1300</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16662.0	15.65	10.05	6.59	2.04	0.95	0.72
Drop 2	12477.0	12.56	8.07	5.28	1.68	0.78	0.59
Drop 3	9311.0	9.96	6.41	4.26	1.32	0.61	0.45
Drop 4	6178.0	7.04	4.57	3.02	0.88	0.38	0.28
Normalized	9000.0	9.67	6.23	4.14	1.28	0.59	0.43
<b>Adjusted Deflection = 11.38 mils</b>		<b>Area = 18.0 in</b>		<b>Modulus = 117.620 ksi</b>			
<b>Station = 1500</b>		<b>Temperature = 67.2 deg F</b>					
Drop 1	16552.0	18.94	13.76	10.47	4.39	2.01	1.38
Drop 2	12389.0	14.96	10.83	8.26	3.49	1.60	1.11
Drop 3	9224.0	11.60	8.31	6.37	2.68	1.23	0.82
Drop 4	6134.0	7.88	5.67	4.29	1.77	0.78	0.51
Normalized	9000.0	11.33	8.12	6.22	2.61	1.20	0.80
<b>Adjusted Deflection = 13.54 mils</b>		<b>Area = 19.0 in</b>		<b>Modulus = 63.787 ksi</b>			
<b>Station = 1700</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16673.0	17.59	11.87	8.89	3.73	1.72	1.02
Drop 2	12368.0	13.59	9.28	7.10	3.06	1.44	0.83
Drop 3	9278.0	10.54	7.24	5.55	2.36	1.11	0.67
Drop 4	6211.0	7.25	5.04	3.84	1.56	0.72	0.43
Normalized	9000.0	10.24	7.04	5.40	2.29	1.07	0.65
<b>Adjusted Deflection = 12.15 mils</b>		<b>Area = 19.5 in</b>		<b>Modulus = 78.522 ksi</b>			
<b>Station = 1900</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16355.0	28.09	21.68	17.22	8.99	5.44	3.76
Drop 2	12346.0	21.50	16.48	13.08	6.78	4.11	2.83
Drop 3	9235.0	15.63	11.90	9.34	4.76	2.83	1.97
Drop 4	6178.0	9.98	7.56	5.79	2.89	1.71	1.18
Normalized	9000.0	15.20	11.57	9.07	4.62	2.74	1.91
<b>Adjusted Deflection = 18.02 mils</b>		<b>Area = 18.2 in</b>		<b>Modulus = 26.529 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 2100</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16432.0	19.71	13.47	9.38	3.35	2.03	1.89
Drop 2	12368.0	15.77	10.81	7.58	2.61	1.55	1.37
Drop 3	9311.0	12.37	8.50	5.93	1.93	1.13	0.98
Drop 4	6069.0	8.55	5.93	3.95	1.22	0.65	0.64
Normalized	9000.0	12.00	8.25	5.74	1.86	1.08	0.95
<b>Adjusted Deflection = 14.23 mils</b>		<b>Area = 16.3 in</b>		<b>Modulus = 53.666 ksi</b>			
<b>Station = 2300</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16497.0	18.19	12.27	8.28	3.39	2.19	1.74
Drop 2	12378.0	14.24	9.65	6.44	2.59	1.69	1.35
Drop 3	9267.0	10.92	7.37	4.86	1.87	1.20	0.92
Drop 4	6189.0	7.32	4.98	3.20	1.14	0.74	0.58
Normalized	9000.0	10.61	7.16	4.72	1.81	1.16	0.89
<b>Adjusted Deflection = 12.58 mils</b>		<b>Area = 16.4 in</b>		<b>Modulus = 57.106 ksi</b>			
<b>Station = 2500</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16311.0	24.78	17.13	12.26	4.67	2.27	1.60
Drop 2	12269.0	19.64	13.54	9.57	3.51	1.69	1.21
Drop 3	9114.0	15.03	10.31	7.17	2.49	1.19	0.89
Drop 4	6025.0	10.10	6.94	4.70	1.55	0.73	0.54
Normalized	9000.0	14.85	10.19	7.08	2.46	1.17	0.88
<b>Adjusted Deflection = 17.61 mils</b>		<b>Area = 16.6 in</b>		<b>Modulus = 57.983 ksi</b>			
<b>Station = 2700</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16333.0	26.85	19.41	14.39	6.15	3.40	2.62
Drop 2	12181.0	21.07	15.18	11.18	4.70	2.56	2.05
Drop 3	9092.0	16.06	11.50	8.36	3.36	1.85	1.50
Drop 4	5992.0	10.57	7.56	5.39	2.07	1.11	0.96
Normalized	9000.0	15.90	11.38	8.27	3.32	1.83	1.48
<b>Adjusted Deflection = 18.71 mils</b>		<b>Area = 16.4 in</b>		<b>Modulus = 34.189 ksi</b>			
<b>Station = 2900</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16289.0	23.32	15.52	10.39	3.00	0.90	0.59
Drop 2	12105.0	18.84	12.83	8.69	2.52	0.78	0.52
Drop 3	9015.0	14.93	10.22	6.94	1.93	0.62	0.41
Drop 4	5937.0	10.41	7.08	4.74	1.22	0.38	0.23
Normalized	9000.0	14.91	10.20	6.93	1.93	0.62	0.41
<b>Adjusted Deflection = 17.55 mils</b>		<b>Area = 18.6 in</b>		<b>Modulus = 124.532 ksi</b>			
<b>Station = 3100</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16136.0	16.57	9.77	6.10	1.15	0.35	0.44
Drop 2	12148.0	13.48	8.00	5.20	0.98	0.33	0.38
Drop 3	9059.0	10.86	6.53	4.25	0.80	0.25	0.27
Drop 4	5981.0	7.72	4.67	2.99	0.53	0.10	0.11
Normalized	9000.0	10.80	6.49	4.23	0.79	0.25	0.27
<b>Adjusted Deflection = 12.71 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 190.974 ksi</b>			
<b>Station = 3300</b>		<b>Temperature = 66.3 deg F</b>					
Drop 1	16103.0	35.84	25.76	19.12	6.58	2.39	1.56
Drop 2	12039.0	28.78	20.62	15.30	5.23	1.91	1.29
Drop 3	8840.0	22.22	15.82	11.72	3.93	1.36	0.93
Drop 4	5883.0	15.10	10.67	7.84	2.48	0.81	0.55
Normalized	9000.0	22.55	16.06	11.90	4.00	1.39	0.95
<b>Adjusted Deflection = 27.30 mils</b>		<b>Area = 17.0 in</b>		<b>Modulus = 53.631 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 3500</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16213.0	33.50	25.09	19.20	8.02	3.97	2.89
Drop 2	12083.0	26.60	19.95	15.25	6.28	3.03	2.20
Drop 3	9005.0	20.47	15.24	11.52	4.56	2.15	1.58
Drop 4	5915.0	13.83	10.26	7.66	2.87	1.30	0.93
Normalized	9000.0	20.46	15.23	11.51	4.56	2.15	1.58
<b>Adjusted Deflection = 24.26 mils</b>		<b>Area = 16.8 in</b>		<b>Modulus = 32.121 ksi</b>			
<b>Station = 3700</b>		<b>Temperature = 67.7 deg F</b>					
Drop 1	16366.0	27.03	19.23	13.76	4.84	1.89	1.13
Drop 2	12159.0	21.20	15.11	10.80	3.74	1.46	0.91
Drop 3	9180.0	16.30	11.46	8.15	2.73	1.07	0.67
Drop 4	5992.0	11.03	7.74	5.43	1.74	0.65	0.46
Normalized	9000.0	16.00	11.25	8.00	2.67	1.05	0.66
<b>Adjusted Deflection = 18.98 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 77.338 ksi</b>			
<b>Station = 3900</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16454.0	22.15	15.47	11.01	3.64	1.07	0.41
Drop 2	12159.0	17.60	12.48	8.98	3.02	0.94	0.41
Drop 3	9256.0	13.54	9.67	6.98	2.32	0.72	0.35
Drop 4	6058.0	9.28	6.66	4.79	1.52	0.48	0.22
Normalized	9000.0	13.20	9.43	6.80	2.26	0.70	0.34
<b>Adjusted Deflection = 15.54 mils</b>		<b>Area = 21.2 in</b>		<b>Modulus = 150.070 ksi</b>			
<b>Station = 4100</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16245.0	26.10	18.79	13.85	5.84	3.07	2.09
Drop 2	12159.0	20.80	14.96	11.01	4.43	2.27	1.55
Drop 3	9246.0	16.03	11.44	8.37	3.20	1.61	1.12
Drop 4	6036.0	10.71	7.62	5.47	1.93	0.95	0.63
Normalized	9000.0	15.62	11.15	8.15	3.10	1.56	1.08
<b>Adjusted Deflection = 18.25 mils</b>		<b>Area = 17.3 in</b>		<b>Modulus = 46.945 ksi</b>			
<b>Station = 4300</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16191.0	24.34	18.07	13.93	6.28	3.28	2.37
Drop 2	12105.0	19.68	14.60	11.20	5.00	2.50	1.78
Drop 3	9114.0	15.26	11.25	8.52	3.60	1.73	1.24
Drop 4	6036.0	10.39	7.66	5.71	2.28	1.06	0.73
Normalized	9000.0	15.08	11.12	8.42	3.55	1.71	1.22
<b>Adjusted Deflection = 17.61 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 41.592 ksi</b>			
<b>Station = 4500</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16169.0	29.23	20.04	14.75	6.15	2.99	2.02
Drop 2	12039.0	23.75	16.39	11.98	4.49	2.27	1.52
Drop 3	8950.0	18.66	12.73	9.17	3.59	1.62	1.07
Drop 4	5948.0	12.82	8.76	6.34	2.37	1.07	0.70
Normalized	9000.0	18.74	12.79	9.22	3.60	1.63	1.08
<b>Adjusted Deflection = 21.89 mils</b>		<b>Area = 16.7 in</b>		<b>Modulus = 47.171 ksi</b>			
<b>Station = 4700</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16245.0	19.67	13.87	10.28	4.74	2.87	2.11
Drop 2	12203.0	15.12	10.63	7.81	3.53	2.15	1.57
Drop 3	9224.0	11.33	7.88	5.72	2.46	1.43	1.07
Drop 4	6069.0	7.39	5.10	3.58	1.41	0.86	0.66
Normalized	9000.0	11.05	7.68	5.57	2.39	1.39	1.04
<b>Adjusted Deflection = 12.91 mils</b>		<b>Area = 17.6 in</b>		<b>Modulus = 48.827 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 4900</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16015.0	30.83	22.96	17.42	8.34	5.19	3.81
Drop 2	12072.0	24.16	18.01	13.59	6.43	3.93	2.94
Drop 3	9158.0	18.34	13.50	10.14	4.62	2.80	2.10
Drop 4	5970.0	11.74	8.61	6.32	2.75	1.66	1.25
Normalized	9000.0	18.01	13.26	9.95	4.53	2.74	2.06
<b>Adjusted Deflection = 21.04 mils</b>		<b>Area = 16.7 in</b>		<b>Modulus = 24.599 ksi</b>			
<b>Station = 5100</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16081.0	25.79	19.12	14.59	7.18	4.44	3.18
Drop 2	12170.0	20.08	14.80	11.25	5.44	3.38	2.45
Drop 3	9081.0	14.98	10.97	8.23	3.89	2.41	1.80
Drop 4	5970.0	9.65	6.96	5.14	2.27	1.43	1.04
Normalized	9000.0	14.84	10.87	8.15	3.85	2.38	1.78
<b>Adjusted Deflection = 17.34 mils</b>		<b>Area = 17.2 in</b>		<b>Modulus = 28.467 ksi</b>			
<b>Station = 5300</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16037.0	23.69	17.59	13.73	6.61	3.93	2.96
Drop 2	12028.0	18.56	13.77	10.69	5.07	3.00	2.29
Drop 3	9048.0	14.11	10.39	8.00	3.64	2.19	1.66
Drop 4	5981.0	9.26	6.74	5.11	2.17	1.24	0.98
Normalized	9000.0	14.03	10.33	7.95	3.62	2.18	1.65
<b>Adjusted Deflection = 16.39 mils</b>		<b>Area = 17.6 in</b>		<b>Modulus = 30.741 ksi</b>			
<b>Station = 5500</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16004.0	25.16	18.29	13.67	6.13	3.50	2.67
Drop 2	12061.0	19.64	14.17	10.48	4.61	2.64	2.06
Drop 3	8983.0	14.63	10.43	7.61	3.23	1.87	1.49
Drop 4	5915.0	9.47	6.68	4.78	1.89	1.09	0.88
Normalized	9000.0	14.66	10.45	7.63	3.24	1.87	1.49
<b>Adjusted Deflection = 17.12 mils</b>		<b>Area = 16.7 in</b>		<b>Modulus = 33.978 ksi</b>			
<b>Station = 5700</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16070.0	18.05	11.75	8.11	2.59	1.11	0.86
Drop 2	12094.0	14.55	9.50	6.74	2.19	0.96	0.74
Drop 3	9103.0	11.60	7.59	5.46	1.75	0.78	0.55
Drop 4	5981.0	7.98	5.39	3.82	1.16	0.46	0.37
Normalized	9000.0	11.48	7.52	5.41	1.73	0.77	0.54
<b>Adjusted Deflection = 13.41 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 93.597 ksi</b>			
<b>Station = 5900</b>		<b>Temperature = 68.7 deg F</b>					
Drop 1	16180.0	23.47	16.47	11.84	3.46	0.20	0.00
Drop 2	11951.0	19.50	14.06	10.20	3.00	0.29	0.04
Drop 3	8961.0	15.69	11.44	8.30	2.42	0.28	0.07
Drop 4	5861.0	11.22	8.22	5.98	1.68	0.18	0.04
Normalized	9000.0	15.74	11.47	8.32	2.43	0.28	0.07
<b>Adjusted Deflection = 18.39 mils</b>		<b>Area = 32.8 in</b>		<b>Modulus = 732.900 ksi</b>			
<b>Station = 6100</b>		<b>Temperature = 68.2 deg F</b>					
Drop 1	16048.0	32.41	14.09	10.14	3.06	0.35	0.00
Drop 2	11962.0	16.50	12.08	8.77	2.65	0.37	0.00
Drop 3	9015.0	13.23	9.79	7.12	2.13	0.32	0.04
Drop 4	5806.0	9.29	6.91	5.01	1.48	0.19	0.00
Normalized	9000.0	13.21	9.78	7.11	2.13	0.32	0.04
<b>Adjusted Deflection = 15.55 mils</b>		<b>Area = 39.9 in</b>		<b>Modulus = 1281.543 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 6300</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	16399.0	28.99	22.10	17.71	9.40	5.36	3.36
Drop 2	12346.0	22.33	16.97	13.56	7.18	4.08	2.56
Drop 3	9256.0	16.46	12.43	9.84	5.09	2.86	1.80
Drop 4	6189.0	10.57	7.93	6.20	3.12	1.73	1.10
Normalized	9000.0	15.97	12.05	9.54	4.93	2.77	1.74
<b>Adjusted Deflection = 18.37 mils</b>		<b>Area = 18.7 in</b>		<b>Modulus = 29.103 ksi</b>			
<b>Station = 6500</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	16191.0	25.82	18.85	14.29	7.27	4.69	3.40
Drop 2	12039.0	46.55	15.07	10.97	5.88	3.67	2.55
Drop 3	9136.0	18.80	11.42	8.01	3.81	2.61	1.83
Drop 4	6025.0	10.40	7.28	5.11	2.57	1.62	1.30
Normalized	9000.0	18.43	11.24	7.88	3.76	2.57	1.81
<b>Adjusted Deflection = 21.20 mils</b>		<b>Area = 15.0 in</b>		<b>Modulus = 28.045 ksi</b>			
<b>Station = 6700</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	16015.0	46.00	35.18	27.50	13.03	6.80	4.02
Drop 2	12094.0	35.25	26.91	21.05	9.98	5.15	3.07
Drop 3	9092.0	25.54	19.36	15.09	7.15	3.63	2.15
Drop 4	6025.0	15.66	11.81	9.17	4.31	2.25	1.37
Normalized	9000.0	25.24	19.13	14.91	7.06	3.59	2.13
<b>Adjusted Deflection = 29.04 mils</b>		<b>Area = 17.5 in</b>		<b>Modulus = 23.798 ksi</b>			
<b>Station = 6900</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	15950.0	37.71	29.13	23.74	13.22	8.24	5.74
Drop 2	11886.0	28.82	22.26	18.06	10.07	6.32	4.44
Drop 3	8939.0	21.00	16.13	13.01	7.22	4.53	3.18
Drop 4	5937.0	12.93	9.89	7.91	4.39	2.76	1.91
Normalized	9000.0	21.16	16.26	13.11	7.28	4.57	3.21
<b>Adjusted Deflection = 24.34 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 15.719 ksi</b>			
<b>Station = 7100</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	16015.0	41.17	32.05	25.65	13.79	7.99	5.47
Drop 2	12116.0	31.84	24.70	19.74	10.68	6.11	4.23
Drop 3	9092.0	23.26	17.93	14.21	7.43	4.40	3.04
Drop 4	6036.0	14.34	10.98	8.62	4.54	2.64	1.87
Normalized	9000.0	22.99	17.72	14.04	7.34	4.35	3.00
<b>Adjusted Deflection = 26.45 mils</b>		<b>Area = 17.6 in</b>		<b>Modulus = 16.785 ksi</b>			
<b>Station = 7300</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	15380.0	78.85	60.69	48.26	22.85	11.63	7.27
Drop 2	11776.0	61.76	47.63	37.64	17.69	9.11	5.71
Drop 3	8829.0	45.31	34.61	27.22	12.69	6.53	4.15
Drop 4	5850.0	27.70	21.09	16.38	7.59	3.95	2.52
Normalized	9000.0	46.26	35.37	27.82	12.98	6.68	4.24
<b>Adjusted Deflection = 53.22 mils</b>		<b>Area = 16.0 in</b>		<b>Modulus = 11.836 ksi</b>			
<b>Station = 7500</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	15347.0	78.62	62.59	50.89	25.38	13.00	7.41
Drop 2	11809.0	61.56	49.04	39.69	19.72	10.14	5.84
Drop 3	8840.0	44.68	35.37	28.42	14.00	7.30	4.19
Drop 4	5850.0	27.14	21.42	17.08	8.48	4.43	2.56
Normalized	9000.0	45.59	36.11	29.03	14.31	7.45	4.28
<b>Adjusted Deflection = 52.44 mils</b>		<b>Area = 16.8 in</b>		<b>Modulus = 11.728 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 7700</b>		<b>Temperature = 69.7 deg F</b>					
Drop 1	15544.0	66.80	52.51	42.57	22.98	12.56	7.80
Drop 2	11907.0	52.20	41.00	33.08	17.81	9.74	6.12
Drop 3	8928.0	38.02	29.77	23.87	12.70	6.94	4.45
Drop 4	5926.0	23.32	18.26	14.49	7.75	4.25	2.67
Normalized	9000.0	38.36	30.04	24.09	12.82	7.01	4.49
<b>Adjusted Deflection = 44.13 mils</b>		<b>Area = 16.9 in</b>		<b>Modulus = 11.166 ksi</b>			
<b>Station = 7900</b>		<b>Temperature = 69.3 deg F</b>					
Drop 1	15851.0	40.86	32.72	27.44	15.56	9.72	6.71
Drop 2	12006.0	32.31	25.84	21.76	12.26	7.63	5.30
Drop 3	8972.0	24.05	19.26	16.11	8.98	5.54	3.81
Drop 4	5926.0	15.40	12.44	10.39	5.74	3.47	2.38
Normalized	9000.0	24.13	19.32	16.16	9.01	5.56	3.82
<b>Adjusted Deflection = 27.92 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 13.148 ksi</b>			
<b>Station = 8100</b>		<b>Temperature = 69.3 deg F</b>					
Drop 1	16004.0	34.04	27.69	23.36	13.46	8.17	5.34
Drop 2	11886.0	26.55	21.63	18.14	10.53	6.30	4.20
Drop 3	9015.0	19.56	15.81	13.22	7.52	4.54	3.07
Drop 4	5970.0	12.31	9.91	8.21	4.57	2.81	1.93
Normalized	9000.0	19.52	15.78	13.20	7.51	4.53	3.06
<b>Adjusted Deflection = 22.60 mils</b>		<b>Area = 19.2 in</b>		<b>Modulus = 16.455 ksi</b>			
<b>Station = 8300</b>		<b>Temperature = 69.3 deg F</b>					
Drop 1	15807.0	50.73	39.88	32.30	17.63	9.79	5.69
Drop 2	11721.0	39.53	31.07	25.15	14.15	7.51	4.43
Drop 3	8753.0	29.17	22.88	18.36	9.94	5.46	3.22
Drop 4	5729.0	17.84	13.96	11.08	5.94	3.20	1.93
Normalized	9000.0	30.03	23.56	18.93	10.29	5.63	3.32
<b>Adjusted Deflection = 34.76 mils</b>		<b>Area = 17.7 in</b>		<b>Modulus = 15.169 ksi</b>			
<b>Station = 8500</b>		<b>Temperature = 69.3 deg F</b>					
Drop 1	15555.0	55.87	47.11	40.52	26.57	17.99	12.51
Drop 2	11557.0	43.64	37.00	31.84	20.81	14.14	9.94
Drop 3	8840.0	32.36	27.44	23.56	15.33	10.47	7.31
Drop 4	5850.0	20.31	17.33	14.73	9.59	6.44	4.62
Normalized	9000.0	33.02	28.00	24.05	15.65	10.69	7.46
<b>Adjusted Deflection = 38.22 mils</b>		<b>Area = 19.0 in</b>		<b>Modulus = 6.638 ksi</b>			
<b>Station = 8700</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15336.0	64.39	53.65	45.03	26.61	16.50	11.14
Drop 2	11655.0	51.04	42.49	35.54	21.02	12.94	8.70
Drop 3	8764.0	38.35	31.78	26.61	15.51	9.48	6.40
Drop 4	5740.0	24.52	20.23	16.73	9.61	5.83	3.90
Normalized	9000.0	39.39	32.65	27.34	15.96	9.76	6.59
<b>Adjusted Deflection = 45.23 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 7.548 ksi</b>			
<b>Station = 8900</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15490.0	38.20	31.59	26.90	16.19	10.05	6.71
Drop 2	11634.0	30.05	24.91	21.15	12.60	7.90	5.25
Drop 3	8785.0	22.51	18.60	15.73	9.22	5.74	3.84
Drop 4	5740.0	14.28	11.78	9.92	5.71	3.54	2.38
Normalized	9000.0	23.08	19.08	16.14	9.48	5.90	3.95
<b>Adjusted Deflection = 26.51 mils</b>		<b>Area = 19.3 in</b>		<b>Modulus = 12.733 ksi</b>			

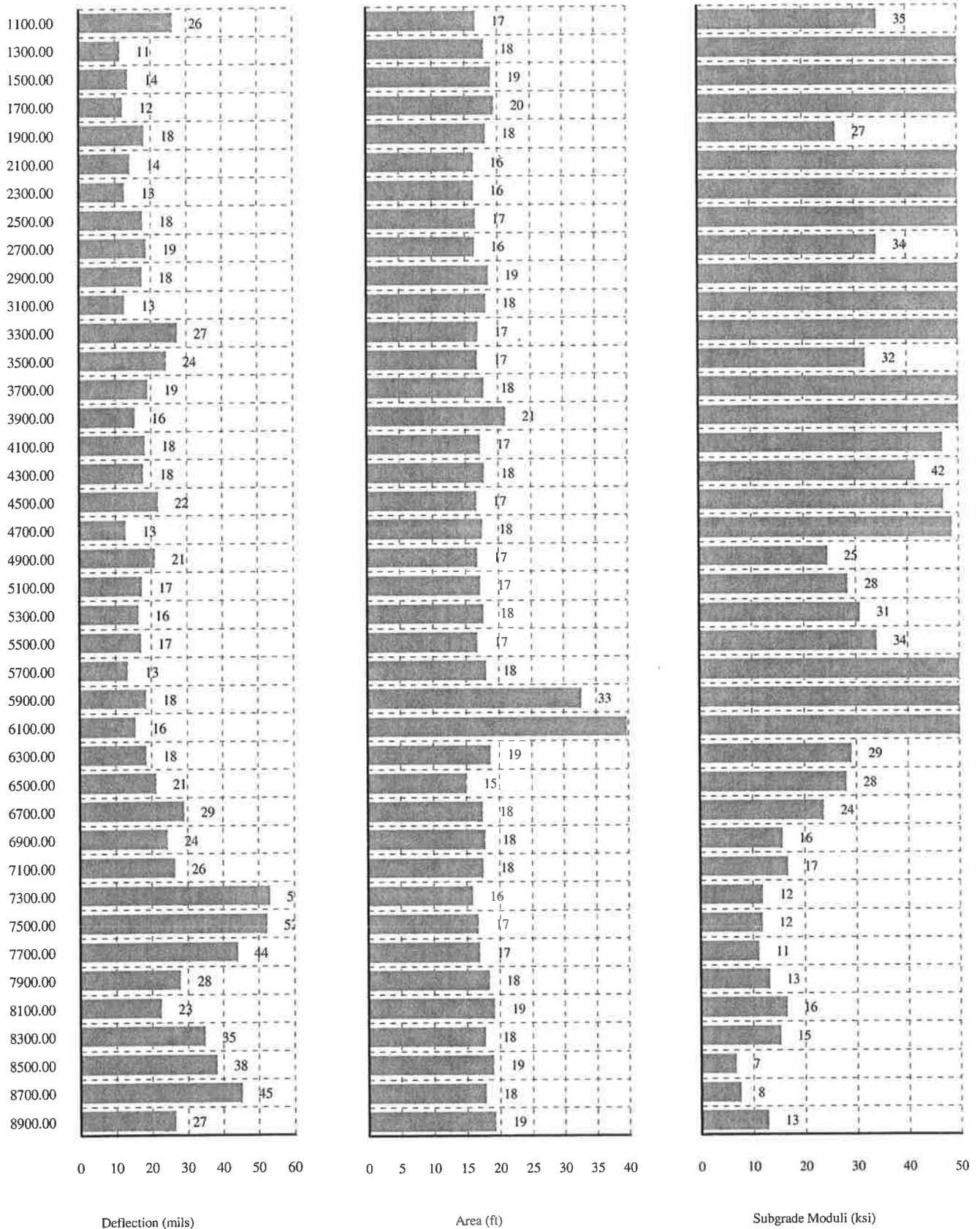
# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 9100</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15829.0	31.69	25.45	21.23	12.90	8.35	5.88
Drop 2	11896.0	25.00	20.19	16.72	10.11	6.47	4.56
Drop 3	8939.0	18.96	15.32	12.67	7.54	4.74	3.33
Drop 4	5872.0	12.42	10.02	8.22	4.80	2.94	2.04
Normalized	9000.0	19.08	15.42	12.75	7.59	4.78	3.36
<b>Adjusted Deflection = 21.92 mils</b>		<b>Area = 19.2 in</b>		<b>Modulus = 15.010 ksi</b>			
<b>Station = 9300</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	16059.0	24.44	19.21	15.86	9.53	6.24	4.45
Drop 2	12083.0	19.00	14.95	12.44	7.58	4.88	3.50
Drop 3	9103.0	14.18	11.18	9.30	5.63	3.60	2.56
Drop 4	5959.0	9.02	7.09	5.87	3.52	2.22	1.54
Normalized	9000.0	14.01	11.05	9.19	5.56	3.55	2.53
<b>Adjusted Deflection = 16.09 mils</b>		<b>Area = 19.9 in</b>		<b>Modulus = 19.999 ksi</b>			
<b>Station = 9500</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15643.0	48.31	39.48	32.51	17.16	9.78	6.33
Drop 2	11962.0	38.01	30.94	25.43	13.31	7.54	4.87
Drop 3	8972.0	27.67	22.41	18.36	9.41	5.27	3.43
Drop 4	5926.0	16.63	13.44	10.89	5.55	3.08	2.03
Normalized	9000.0	27.77	22.49	18.43	9.45	5.29	3.44
<b>Adjusted Deflection = 31.89 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 14.621 ksi</b>			
<b>Station = 9700</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15796.0	40.46	32.24	25.98	13.67	7.52	4.53
Drop 2	12148.0	31.54	25.07	20.16	10.59	5.81	3.45
Drop 3	9037.0	22.98	18.17	14.53	7.51	4.10	2.43
Drop 4	5981.0	14.13	11.13	8.81	4.52	2.47	1.46
Normalized	9000.0	22.87	18.08	14.46	7.47	4.08	2.42
<b>Adjusted Deflection = 26.27 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 20.904 ksi</b>			
<b>Station = 9900</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15665.0	46.73	38.85	31.96	18.90	11.74	7.92
Drop 2	11842.0	36.67	30.47	25.02	14.75	9.11	6.17
Drop 3	9005.0	26.78	22.11	18.07	10.61	6.53	4.43
Drop 4	5959.0	16.14	13.36	10.74	6.33	3.86	2.65
Normalized	9000.0	26.76	22.10	18.06	10.60	6.53	4.43
<b>Adjusted Deflection = 30.74 mils</b>		<b>Area = 18.5 in</b>		<b>Modulus = 11.329 ksi</b>			
<b>Station = 10100</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15687.0	46.18	37.82	31.59	18.09	11.18	7.41
Drop 2	11940.0	36.11	29.53	24.65	14.07	8.66	5.75
Drop 3	9081.0	26.18	21.36	17.67	10.01	6.17	4.11
Drop 4	5926.0	15.44	12.55	10.32	5.80	3.57	2.41
Normalized	9000.0	25.90	21.13	17.48	9.90	6.10	4.07
<b>Adjusted Deflection = 29.75 mils</b>		<b>Area = 18.5 in</b>		<b>Modulus = 12.351 ksi</b>			
<b>Station = 10300</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15687.0	64.55	53.19	42.40	25.18	14.50	9.65
Drop 2	13310.0	50.93	41.94	33.84	19.67	11.17	7.42
Drop 3	9892.0	37.54	31.06	25.36	14.13	7.95	5.36
Drop 4	6288.0	23.16	19.31	15.50	8.47	4.74	3.18
Normalized	9000.0	33.98	28.15	22.92	12.73	7.16	4.82
<b>Adjusted Deflection = 39.03 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 10.388 ksi</b>			

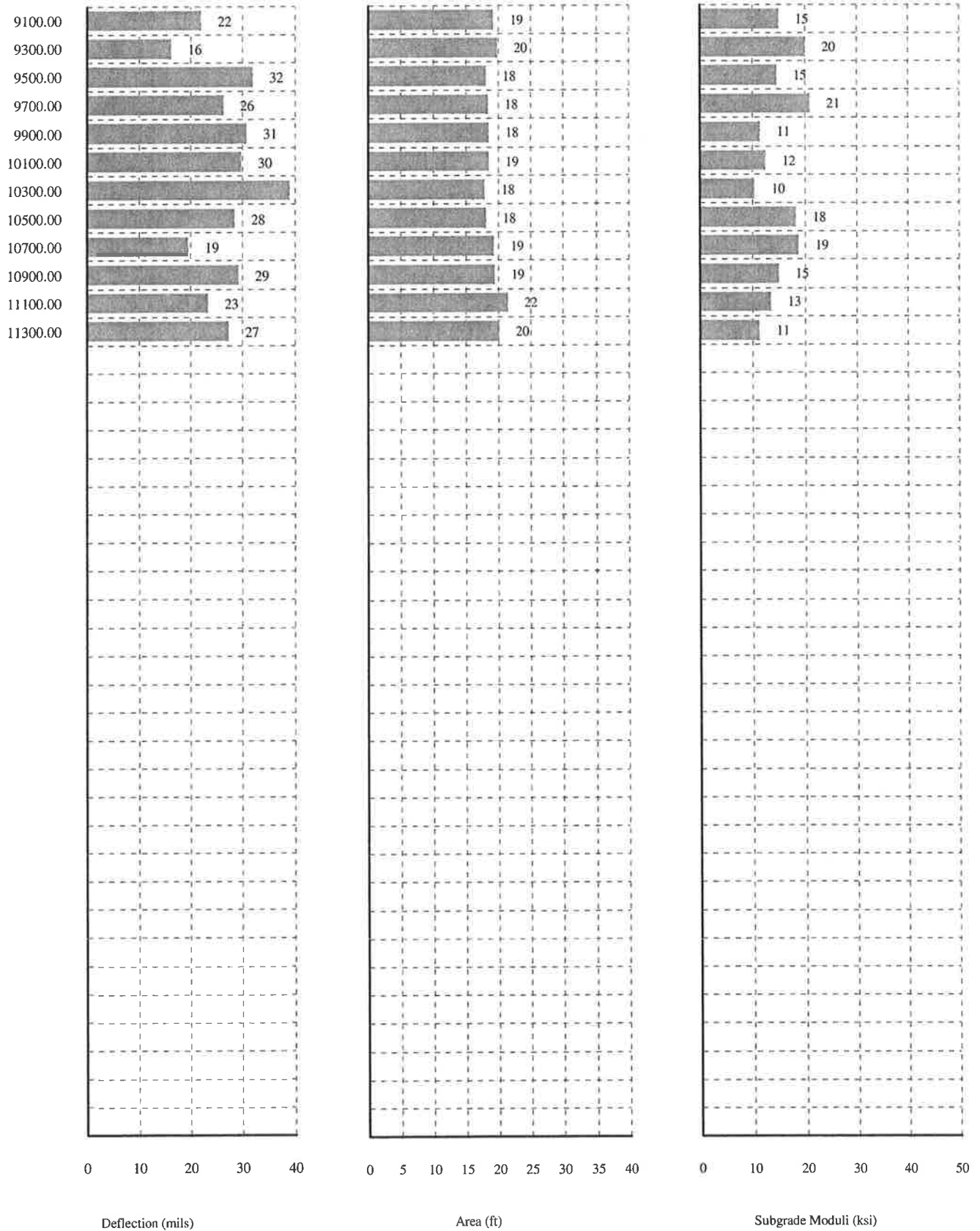
## FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 10500</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15851.0	42.00	33.41	26.98	14.11	7.81	4.89
Drop 2	12116.0	33.26	26.42	21.35	11.14	6.09	3.81
Drop 3	9015.0	24.79	19.61	15.74	8.15	4.40	2.76
Drop 4	5948.0	15.69	12.34	9.81	5.04	2.72	1.69
Normalized	9000.0	24.75	19.57	15.71	8.13	4.39	2.75
<b>Adjusted Deflection = 28.42 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 18.326 ksi</b>			
<b>Station = 10700</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15928.0	30.24	24.58	20.35	11.61	7.23	4.93
Drop 2	12214.0	23.58	19.11	15.75	8.97	5.57	3.83
Drop 3	9191.0	17.31	13.94	11.44	6.47	4.02	2.75
Drop 4	6058.0	10.74	8.66	7.06	3.96	2.43	1.67
Normalized	9000.0	16.91	13.62	11.17	6.32	3.92	2.68
<b>Adjusted Deflection = 19.42 mils</b>		<b>Area = 19.3 in</b>		<b>Modulus = 18.814 ksi</b>			
<b>Station = 10900</b>		<b>Temperature = 69.8 deg F</b>					
Drop 1	15698.0	44.24	36.57	31.22	17.94	10.08	5.96
Drop 2	12083.0	34.98	28.90	24.61	14.10	7.96	4.67
Drop 3	9092.0	25.73	21.24	18.04	10.24	5.72	3.41
Drop 4	5959.0	15.90	13.09	11.04	6.21	3.46	2.10
Normalized	9000.0	25.44	21.00	17.83	10.12	5.65	3.37
<b>Adjusted Deflection = 29.22 mils</b>		<b>Area = 19.4 in</b>		<b>Modulus = 14.938 ksi</b>			
<b>Station = 11100</b>		<b>Temperature = 69.9 deg F</b>					
Drop 1	15807.0	34.96	32.63	28.17	17.01	10.34	6.48
Drop 2	12105.0	27.58	25.64	22.09	13.41	8.25	5.13
Drop 3	9081.0	20.53	18.98	16.31	9.88	6.06	3.78
Drop 4	5970.0	13.06	12.00	10.27	6.22	3.83	2.37
Normalized	9000.0	20.34	18.80	16.15	9.78	6.00	3.74
<b>Adjusted Deflection = 23.32 mils</b>		<b>Area = 21.5 in</b>		<b>Modulus = 13.434 ksi</b>			
<b>Station = 11300</b>		<b>Temperature = 69.9 deg F</b>					
Drop 1	15676.0	41.40	35.37	30.68	19.39	12.07	7.80
Drop 2	12028.0	32.48	27.76	24.01	15.14	9.47	6.10
Drop 3	9005.0	23.74	20.27	17.48	10.96	6.82	4.44
Drop 4	5926.0	14.66	12.56	10.77	6.75	4.18	2.75
Normalized	9000.0	23.73	20.26	17.47	10.95	6.82	4.44
<b>Adjusted Deflection = 27.21 mils</b>		<b>Area = 20.1 in</b>		<b>Modulus = 11.302 ksi</b>			

# FWD - Non Destructive Pavement Testing



# FWD - Non Destructive Pavement Testing



**SE 416<sup>th</sup> Street Overlay: Shingles in Paving  
Demonstration**

**Pre-Construction Falling Weight Deflectometer Data**

**Westbound Lane**

# FWD - Non Destructive Pavement Testing

**Route: SE 416th Street**

**Section: 212th Ave SE to 244th Ave SE (WB Lane)**

NOTE: Summary values are adjusted to 9,000 pounds load and adjusted for pavement thickness and temperature. Modulus determination is based on the deflection 48 in From Load.

FWD File = G:\Pavement\FWD-TEST\King County\FWD\Before\SE  
416th St - RAS Study WBN.FWD

Date Tested = 08/05/09

Thickness = Thick AC (> 4 in)

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 11400</b>		<b>Temperature = 70 deg F</b>					
Drop 1	15676.0	55.04	45.36	37.70	22.13	13.46	8.35
Drop 2	12072.0	43.59	35.90	29.81	17.44	10.59	6.56
Drop 3	9015.0	32.12	26.45	21.86	12.81	7.74	4.85
Drop 4	5981.0	20.08	16.59	13.67	8.05	4.86	3.04
Normalized	9000.0	32.06	26.40	21.82	12.79	7.73	4.84
<b>Adjusted Deflection = 36.71 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 10.343 ksi</b>			
<b>Station = 11200</b>		<b>Temperature = 70 deg F</b>					
Drop 1	15533.0	62.78	52.64	44.26	24.33	13.44	7.76
Drop 2	11907.0	49.99	42.03	35.09	19.09	10.40	6.14
Drop 3	8939.0	37.19	31.18	25.94	13.89	7.54	4.39
Drop 4	5926.0	23.30	19.54	16.11	8.54	4.59	2.86
Normalized	9000.0	37.45	31.40	26.13	14.00	7.60	4.43
<b>Adjusted Deflection = 42.88 mils</b>		<b>Area = 18.3 in</b>		<b>Modulus = 11.332 ksi</b>			
<b>Station = 11000</b>		<b>Temperature = 70 deg F</b>					
Drop 1	15665.0	49.06	40.59	33.05	17.78	10.20	6.93
Drop 2	12094.0	39.53	32.81	26.67	14.24	8.13	5.54
Drop 3	9005.0	29.73	24.72	20.01	10.54	5.98	4.03
Drop 4	5915.0	18.91	15.83	12.70	6.65	3.73	2.56
Normalized	9000.0	29.71	24.71	20.00	10.53	5.98	4.03
<b>Adjusted Deflection = 34.02 mils</b>		<b>Area = 18.0 in</b>		<b>Modulus = 12.472 ksi</b>			
<b>Station = 10800</b>		<b>Temperature = 70 deg F</b>					
Drop 1	15490.0	62.40	50.65	40.93	20.29	10.53	6.15
Drop 2	11995.0	50.12	40.50	32.56	15.90	8.29	4.87
Drop 3	8939.0	37.68	30.23	24.22	11.61	5.98	3.48
Drop 4	5904.0	23.97	19.21	15.19	7.19	3.70	2.12
Normalized	9000.0	37.93	30.44	24.39	11.70	6.03	3.51
<b>Adjusted Deflection = 43.43 mils</b>		<b>Area = 17.3 in</b>		<b>Modulus = 14.350 ksi</b>			
<b>Station = 10600</b>		<b>Temperature = 70 deg F</b>					
Drop 1	15610.0	52.74	42.84	34.88	17.82	9.67	5.74
Drop 2	11984.0	42.69	34.71	28.31	14.21	7.61	4.58
Drop 3	8950.0	32.49	26.44	21.39	10.55	5.58	3.35
Drop 4	5883.0	20.75	16.98	13.68	6.65	3.47	2.07
Normalized	9000.0	32.66	26.58	21.50	10.61	5.61	3.37
<b>Adjusted Deflection = 37.39 mils</b>		<b>Area = 17.8 in</b>		<b>Modulus = 14.943 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 10400</b>		<b>Temperature = 70.1 deg F</b>					
Drop 1	15413.0	63.59	52.59	43.98	23.60	12.82	7.63
Drop 2	11864.0	50.81	41.93	34.85	18.31	9.91	5.94
Drop 3	8906.0	37.71	30.98	25.59	13.17	7.07	4.28
Drop 4	5872.0	23.28	19.15	15.62	7.84	4.22	2.61
Normalized	9000.0	38.13	31.33	25.88	13.33	7.16	4.33
<b>Adjusted Deflection = 43.58 mils</b>		<b>Area = 17.8 in</b>		<b>Modulus = 11.580 ksi</b>			
<b>Station = 10200</b>		<b>Temperature = 70.2 deg F</b>					
Drop 1	15577.0	60.61	50.95	42.83	24.31	13.99	8.80
Drop 2	11995.0	47.96	40.30	33.76	18.99	10.94	6.78
Drop 3	9015.0	35.40	29.61	24.68	13.74	7.80	4.86
Drop 4	5926.0	21.40	17.94	14.88	8.21	4.63	2.87
Normalized	9000.0	35.33	29.55	24.63	13.71	7.78	4.85
<b>Adjusted Deflection = 40.33 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 10.323 ksi</b>			
<b>Station = 10000</b>		<b>Temperature = 70.7 deg F</b>					
Drop 1	15741.0	49.91	40.94	34.09	20.25	13.29	9.54
Drop 2	12006.0	38.70	31.65	26.35	15.63	10.30	7.37
Drop 3	9037.0	28.27	22.98	19.06	11.25	7.39	5.31
Drop 4	5948.0	17.36	14.13	11.59	6.89	4.51	3.25
Normalized	9000.0	28.14	22.87	18.97	11.20	7.36	5.29
<b>Adjusted Deflection = 31.87 mils</b>		<b>Area = 18.3 in</b>		<b>Modulus = 9.457 ksi</b>			
<b>Station = 9800</b>		<b>Temperature = 70.7 deg F</b>					
Drop 1	15676.0	53.94	43.15	34.64	17.61	9.75	5.74
Drop 2	12137.0	42.90	34.04	27.28	13.74	7.52	4.41
Drop 3	9048.0	31.25	24.86	19.85	9.87	5.37	3.17
Drop 4	5937.0	19.06	15.14	12.00	5.87	3.17	1.85
Normalized	9000.0	31.06	24.71	19.73	9.81	5.34	3.15
<b>Adjusted Deflection = 35.18 mils</b>		<b>Area = 17.7 in</b>		<b>Modulus = 16.004 ksi</b>			
<b>Station = 9600</b>		<b>Temperature = 70.9 deg F</b>					
Drop 1	15621.0	61.65	49.10	39.43	20.06	10.45	6.05
Drop 2	12127.0	49.20	39.27	31.42	15.64	8.04	4.68
Drop 3	9092.0	36.84	29.33	23.31	11.32	5.69	3.31
Drop 4	5937.0	22.91	18.19	14.33	6.77	3.34	1.96
Normalized	9000.0	36.43	29.01	23.05	11.19	5.62	3.27
<b>Adjusted Deflection = 41.13 mils</b>		<b>Area = 17.4 in</b>		<b>Modulus = 15.404 ksi</b>			
<b>Station = 9400</b>		<b>Temperature = 71.4 deg F</b>					
Drop 1	16136.0	40.40	31.51	25.13	13.11	7.33	4.97
Drop 2	12291.0	32.31	25.27	20.23	10.44	5.80	4.01
Drop 3	9180.0	24.73	19.27	15.34	7.80	4.28	2.95
Drop 4	6036.0	16.05	12.61	9.94	4.98	2.73	1.87
Normalized	9000.0	24.23	18.89	15.03	7.64	4.19	2.89
<b>Adjusted Deflection = 27.14 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 17.471 ksi</b>			
<b>Station = 9200</b>		<b>Temperature = 71.4 deg F</b>					
Drop 1	16158.0	30.62	24.04	19.73	11.32	7.03	4.96
Drop 2	12236.0	24.35	19.13	15.65	8.92	5.50	3.92
Drop 3	9256.0	18.66	14.62	11.87	6.65	4.01	2.81
Drop 4	6091.0	12.14	9.58	7.64	4.18	2.47	1.71
Normalized	9000.0	18.13	14.21	11.53	6.45	3.89	2.72
<b>Adjusted Deflection = 20.31 mils</b>		<b>Area = 18.9 in</b>		<b>Modulus = 18.556 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 9000</b>		<b>Temperature = 71.5 deg F</b>					
Drop 1	16169.0	30.15	23.41	19.54	11.65	7.36	4.83
Drop 2	12116.0	23.10	17.81	14.85	8.82	5.62	3.77
Drop 3	9224.0	16.72	12.78	10.60	6.31	4.05	2.74
Drop 4	6091.0	10.06	7.63	6.30	3.74	2.41	1.63
Normalized	9000.0	16.24	12.41	10.29	6.13	3.93	2.66
<b>Adjusted Deflection = 18.16 mils</b>		<b>Area = 19.4 in</b>		<b>Modulus = 18.982 ksi</b>			
<b>Station = 8800</b>		<b>Temperature = 71.5 deg F</b>					
Drop 1	15752.0	47.38	37.73	30.61	16.38	11.18	8.22
Drop 2	11798.0	37.45	29.73	24.04	12.68	8.62	6.38
Drop 3	8873.0	28.43	22.48	18.15	9.62	6.25	4.82
Drop 4	5828.0	18.35	14.52	11.64	6.19	3.92	3.06
Normalized	9000.0	28.82	22.79	18.41	9.75	6.35	4.89
<b>Adjusted Deflection = 32.23 mils</b>		<b>Area = 17.3 in</b>		<b>Modulus = 10.242 ksi</b>			
<b>Station = 8600</b>		<b>Temperature = 72.5 deg F</b>					
Drop 1	15665.0	50.63	43.22	36.97	23.52	15.94	11.26
Drop 2	11973.0	39.34	33.61	28.69	18.37	12.36	8.80
Drop 3	8994.0	28.64	24.46	20.84	13.34	9.01	6.45
Drop 4	5981.0	17.79	15.26	12.93	8.30	5.59	4.11
Normalized	9000.0	28.66	24.48	20.86	13.35	9.02	6.45
<b>Adjusted Deflection = 31.53 mils</b>		<b>Area = 19.7 in</b>		<b>Modulus = 7.708 ksi</b>			
<b>Station = 8400</b>		<b>Temperature = 72.5 deg F</b>					
Drop 1	16234.0	23.99	19.42	16.51	10.57	7.04	4.84
Drop 2	12192.0	18.14	14.66	12.44	8.01	5.37	3.80
Drop 3	9267.0	13.11	10.55	8.93	5.72	3.88	2.74
Drop 4	6113.0	8.01	6.41	5.41	3.45	2.34	1.67
Normalized	9000.0	12.68	10.20	8.63	5.53	3.75	2.65
<b>Adjusted Deflection = 13.95 mils</b>		<b>Area = 21.2 in</b>		<b>Modulus = 19.063 ksi</b>			
<b>Station = 8200</b>		<b>Temperature = 72.7 deg F</b>					
Drop 1	15807.0	44.96	34.09	26.70	13.58	7.71	4.84
Drop 2	12181.0	34.48	26.57	20.74	10.43	5.95	3.77
Drop 3	9092.0	25.32	19.32	14.95	7.35	4.23	2.68
Drop 4	5948.0	15.70	11.88	9.00	4.34	2.54	1.67
Normalized	9000.0	25.04	19.10	14.78	7.26	4.18	2.65
<b>Adjusted Deflection = 27.46 mils</b>		<b>Area = 17.6 in</b>		<b>Modulus = 19.055 ksi</b>			
<b>Station = 8000</b>		<b>Temperature = 72.7 deg F</b>					
Drop 1	16070.0	28.28	24.13	20.99	13.68	9.22	6.72
Drop 2	11951.0	22.62	19.33	16.83	10.94	7.35	5.36
Drop 3	9048.0	17.28	14.70	12.80	8.25	5.52	4.00
Drop 4	5959.0	11.30	9.65	8.37	5.34	3.55	2.56
Normalized	9000.0	17.19	14.62	12.73	8.20	5.49	3.98
<b>Adjusted Deflection = 18.85 mils</b>		<b>Area = 21.3 in</b>		<b>Modulus = 12.631 ksi</b>			
<b>Station = 7800</b>		<b>Temperature = 72.7 deg F</b>					
Drop 1	15654.0	59.02	48.06	39.87	21.91	12.63	8.04
Drop 2	11951.0	46.49	37.83	31.19	16.83	9.67	6.30
Drop 3	8950.0	34.40	27.75	22.75	12.00	6.91	4.49
Drop 4	5915.0	21.31	17.09	13.83	7.16	4.17	2.76
Normalized	9000.0	34.60	27.92	22.89	12.08	6.96	4.52
<b>Adjusted Deflection = 37.95 mils</b>		<b>Area = 17.9 in</b>		<b>Modulus = 11.091 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 7600</b>		<b>Temperature = 72.8 deg F</b>					
Drop 1	15073.0	95.15	77.72	63.74	31.20	15.31	8.81
Drop 2	11568.0	76.59	62.55	50.80	24.12	11.96	6.96
Drop 3	8720.0	58.38	47.08	37.81	17.50	8.68	5.04
Drop 4	5696.0	36.88	29.78	23.65	10.78	5.37	3.11
Normalized	9000.0	60.17	48.60	39.09	18.15	9.00	5.23
<b>Adjusted Deflection = 65.88 mils</b>		<b>Area = 16.7 in</b>		<b>Modulus = 9.561 ksi</b>			
<b>Station = 7400</b>		<b>Temperature = 72.8 deg F</b>					
Drop 1	15106.0	84.88	66.98	54.24	25.39	12.03	6.76
Drop 2	11721.0	66.97	52.89	42.62	19.84	9.60	5.30
Drop 3	8764.0	48.80	38.21	30.78	14.23	6.91	3.86
Drop 4	5795.0	29.86	23.27	18.67	8.69	4.22	2.36
Normalized	9000.0	50.25	39.38	31.72	14.68	7.12	3.97
<b>Adjusted Deflection = 55.02 mils</b>		<b>Area = 16.9 in</b>		<b>Modulus = 12.640 ksi</b>			
<b>Station = 7200</b>		<b>Temperature = 72.8 deg F</b>					
Drop 1	15391.0	72.81	61.76	51.36	26.69	12.08	6.64
Drop 2	11710.0	57.36	48.77	40.43	21.08	12.31	5.21
Drop 3	8785.0	44.44	36.46	30.02	15.82	6.93	3.81
Drop 4	5740.0	27.63	23.01	18.91	9.63	4.31	2.36
Normalized	9000.0	45.39	37.36	30.79	16.21	7.33	3.91
<b>Adjusted Deflection = 49.70 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 12.843 ksi</b>			
<b>Station = 7000</b>		<b>Temperature = 72.9 deg F</b>					
Drop 1	15741.0	49.75	37.69	30.22	15.66	8.98	6.19
Drop 2	12006.0	38.41	29.11	23.36	12.00	6.94	4.81
Drop 3	8983.0	28.11	21.21	16.83	8.53	4.94	3.49
Drop 4	5883.0	17.20	12.89	10.12	5.08	3.00	2.13
Normalized	9000.0	28.17	21.25	16.87	8.55	4.95	3.50
<b>Adjusted Deflection = 30.79 mils</b>		<b>Area = 17.2 in</b>		<b>Modulus = 14.393 ksi</b>			
<b>Station = 6800</b>		<b>Temperature = 72.9 deg F</b>					
Drop 1	15599.0	62.35	42.45	32.80	15.73	8.54	5.08
Drop 2	11886.0	43.13	32.42	24.98	11.83	6.49	3.90
Drop 3	8906.0	30.86	23.32	17.79	8.25	4.58	2.77
Drop 4	5861.0	18.56	13.89	10.44	4.81	2.70	1.67
Normalized	9000.0	31.25	23.61	18.02	8.36	4.64	2.81
<b>Adjusted Deflection = 34.16 mils</b>		<b>Area = 16.9 in</b>		<b>Modulus = 17.990 ksi</b>			
<b>Station = 6600</b>		<b>Temperature = 72.9 deg F</b>					
Drop 1	15533.0	51.30	40.27	32.83	17.45	9.73	5.93
Drop 2	11820.0	38.99	30.69	25.02	13.12	7.34	4.46
Drop 3	8873.0	28.42	22.24	18.01	9.30	5.19	3.17
Drop 4	5817.0	17.23	13.43	10.77	5.47	3.05	1.89
Normalized	9000.0	28.88	22.60	18.31	9.46	5.28	3.23
<b>Adjusted Deflection = 31.56 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 15.622 ksi</b>			
<b>Station = 6400</b>		<b>Temperature = 73 deg F</b>					
Drop 1	15238.0	53.23	42.66	35.15	18.99	10.74	6.59
Drop 2	11557.0	41.10	32.89	26.91	14.38	8.11	5.14
Drop 3	8698.0	29.88	23.80	19.34	10.21	5.81	3.68
Drop 4	5729.0	18.02	14.31	11.52	6.09	3.44	2.25
Normalized	9000.0	31.07	24.76	20.14	10.65	6.05	3.83
<b>Adjusted Deflection = 33.90 mils</b>		<b>Area = 18.1 in</b>		<b>Modulus = 13.111 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 6200</b>		<b>Temperature = 74 deg F</b>					
Drop 1	16519.0	22.90	14.67	10.15	2.30	0.00	0.04
Drop 2	12313.0	18.26	11.94	8.30	1.91	0.05	0.16
Drop 3	9125.0	14.26	9.35	6.54	1.48	0.08	0.13
Drop 4	5970.0	9.71	6.38	4.43	0.96	0.05	0.08
Normalized	9000.0	14.08	9.23	6.46	1.46	0.08	0.13
<b>Adjusted Deflection = 15.11 mils</b>		<b>Area = 25.3 in</b>		<b>Modulus = 398.415 ksi</b>			
<b>Station = 6000</b>		<b>Temperature = 74 deg F</b>					
Drop 1	16344.0	15.62	9.96	6.98	1.65	0.05	0.17
Drop 2	12225.0	12.70	8.25	5.94	1.41	0.09	0.19
Drop 3	9256.0	10.36	6.80	4.89	1.15	0.10	0.18
Drop 4	6113.0	7.37	4.89	3.52	0.81	0.06	0.10
Normalized	9000.0	10.12	6.64	4.78	1.12	0.10	0.17
<b>Adjusted Deflection = 10.86 mils</b>		<b>Area = 23.7 in</b>		<b>Modulus = 293.950 ksi</b>			
<b>Station = 6000</b>		<b>Temperature = 74.1 deg F</b>					
Drop 1	16278.0	15.20	9.80	6.98	1.75	0.13	0.22
Drop 2	12247.0	12.57	8.26	5.96	1.50	0.11	0.20
Drop 3	9224.0	10.23	6.78	4.89	1.20	0.11	0.17
Drop 4	6014.0	7.28	4.89	3.53	0.87	0.07	0.12
Normalized	9000.0	10.02	6.65	4.80	1.18	0.11	0.17
<b>Adjusted Deflection = 10.74 mils</b>		<b>Area = 24.3 in</b>		<b>Modulus = 306.268 ksi</b>			
<b>Station = 5800</b>		<b>Temperature = 74.1 deg F</b>					
Drop 1	16289.0	19.13	13.49	10.08	3.13	0.28	0.00
Drop 2	12148.0	15.57	11.22	8.51	2.71	0.32	0.01
Drop 3	9103.0	12.33	8.94	6.83	2.21	0.31	0.06
Drop 4	5981.0	8.43	6.22	4.76	1.54	0.23	0.03
Normalized	9000.0	12.20	8.85	6.76	2.19	0.31	0.06
<b>Adjusted Deflection = 13.07 mils</b>		<b>Area = 37.7 in</b>		<b>Modulus = 864.567 ksi</b>			
<b>Station = 5600</b>		<b>Temperature = 74.1 deg F</b>					
Drop 1	16245.0	25.30	20.12	16.58	9.12	5.70	4.24
Drop 2	12324.0	19.45	15.52	12.76	6.99	4.39	3.33
Drop 3	9246.0	14.28	11.37	9.32	5.06	3.16	2.44
Drop 4	6134.0	9.13	7.29	5.94	3.15	1.96	1.50
Normalized	9000.0	13.87	11.05	9.05	4.91	3.07	2.37
<b>Adjusted Deflection = 14.87 mils</b>		<b>Area = 20.0 in</b>		<b>Modulus = 21.373 ksi</b>			
<b>Station = 5400</b>		<b>Temperature = 74.2 deg F</b>					
Drop 1	16311.0	22.74	16.73	13.03	6.24	3.47	2.62
Drop 2	12225.0	17.86	13.14	10.17	4.81	2.64	2.00
Drop 3	9278.0	13.54	9.91	7.59	3.49	1.87	1.46
Drop 4	6200.0	9.10	6.64	5.00	2.19	1.14	0.89
Normalized	9000.0	13.14	9.61	7.36	3.37	1.80	1.41
<b>Adjusted Deflection = 14.06 mils</b>		<b>Area = 18.7 in</b>		<b>Modulus = 36.032 ksi</b>			
<b>Station = 5200</b>		<b>Temperature = 74.7 deg F</b>					
Drop 1	16125.0	25.41	19.67	15.46	8.00	4.91	3.54
Drop 2	12280.0	19.85	15.36	11.99	6.14	3.76	2.71
Drop 3	9224.0	14.95	11.55	8.91	4.41	2.71	1.96
Drop 4	6091.0	9.77	7.56	5.74	2.73	1.65	1.22
Normalized	9000.0	14.58	11.26	8.68	4.29	2.63	1.91
<b>Adjusted Deflection = 15.47 mils</b>		<b>Area = 19.0 in</b>		<b>Modulus = 26.560 ksi</b>			

# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 5000</b>		<b>Temperature = 74.7 deg F</b>					
Drop 1	16059.0	27.23	19.90	15.46	7.73	5.15	4.12
Drop 2	12050.0	21.58	15.78	12.14	5.89	3.91	3.22
Drop 3	9213.0	16.67	12.10	9.19	4.30	2.87	2.31
Drop 4	5981.0	10.90	7.89	5.87	2.60	1.72	1.40
Normalized	9000.0	16.29	11.82	8.97	4.19	2.79	2.25
<b>Adjusted Deflection = 17.28 mils</b>		<b>Area = 17.4 in</b>		<b>Modulus = 22.482 ksi</b>			
<b>Station = 4800</b>		<b>Temperature = 74.8 deg F</b>					
Drop 1	16081.0	26.92	20.95	16.96	9.54	6.04	4.40
Drop 2	12148.0	21.09	16.33	13.16	7.33	4.62	3.40
Drop 3	9136.0	15.78	12.09	9.68	5.27	3.32	2.45
Drop 4	6058.0	10.24	7.80	6.15	3.26	2.00	1.47
Normalized	9000.0	15.54	11.90	9.52	5.18	3.26	2.41
<b>Adjusted Deflection = 16.45 mils</b>		<b>Area = 19.2 in</b>		<b>Modulus = 21.005 ksi</b>			
<b>Station = 4600</b>		<b>Temperature = 75 deg F</b>					
Drop 1	16289.0	22.01	16.31	12.90	5.80	2.70	1.66
Drop 2	12137.0	17.09	12.60	9.93	4.40	2.00	1.24
Drop 3	9180.0	12.97	9.47	7.41	3.19	1.39	0.87
Drop 4	6069.0	8.47	6.19	4.78	2.05	0.87	0.54
Normalized	9000.0	12.71	9.28	7.26	3.12	1.36	0.85
<b>Adjusted Deflection = 13.41 mils</b>		<b>Area = 20.5 in</b>		<b>Modulus = 59.773 ksi</b>			
<b>Station = 4400</b>		<b>Temperature = 75 deg F</b>					
Drop 1	16333.0	23.30	16.87	12.83	5.79	3.05	2.04
Drop 2	12225.0	18.59	13.50	10.24	4.50	2.29	1.48
Drop 3	9202.0	14.37	10.41	7.81	3.29	1.63	1.09
Drop 4	6156.0	9.87	7.13	5.24	2.09	1.00	0.68
Normalized	9000.0	14.07	10.19	7.64	3.21	1.59	1.06
<b>Adjusted Deflection = 14.85 mils</b>		<b>Area = 19.0 in</b>		<b>Modulus = 47.816 ksi</b>			
<b>Station = 4200</b>		<b>Temperature = 75.5 deg F</b>					
Drop 1	16147.0	26.93	19.11	13.89	5.94	3.14	2.14
Drop 2	12269.0	21.50	15.34	11.13	4.62	2.38	1.61
Drop 3	9191.0	16.44	11.71	8.40	3.35	1.69	1.15
Drop 4	5981.0	10.98	7.83	5.56	2.11	1.06	0.72
Normalized	9000.0	16.12	11.48	8.23	3.28	1.65	1.12
<b>Adjusted Deflection = 16.86 mils</b>		<b>Area = 18.0 in</b>		<b>Modulus = 45.186 ksi</b>			
<b>Station = 4000</b>		<b>Temperature = 75.6 deg F</b>					
Drop 1	16256.0	22.96	15.98	11.70	3.78	0.66	0.05
Drop 2	12039.0	18.25	13.07	9.73	3.20	0.61	0.13
Drop 3	8972.0	14.04	10.18	7.63	2.52	0.50	0.11
Drop 4	5915.0	9.52	6.97	5.22	1.69	0.35	0.10
Normalized	9000.0	14.08	10.21	7.65	2.53	0.50	0.11
<b>Adjusted Deflection = 14.71 mils</b>		<b>Area = 31.3 in</b>		<b>Modulus = 462.942 ksi</b>			
<b>Station = 3800</b>		<b>Temperature = 73 deg F</b>					
Drop 1	16223.0	19.43	13.69	10.19	3.37	0.82	0.24
Drop 2	12017.0	15.56	11.20	8.47	2.83	0.73	0.28
Drop 3	9103.0	12.08	8.76	6.63	2.18	0.59	0.25
Drop 4	5970.0	8.27	6.02	4.52	1.43	0.38	0.17
Normalized	9000.0	11.95	8.67	6.56	2.16	0.58	0.25
<b>Adjusted Deflection = 13.05 mils</b>		<b>Area = 24.6 in</b>		<b>Modulus = 206.092 ksi</b>			

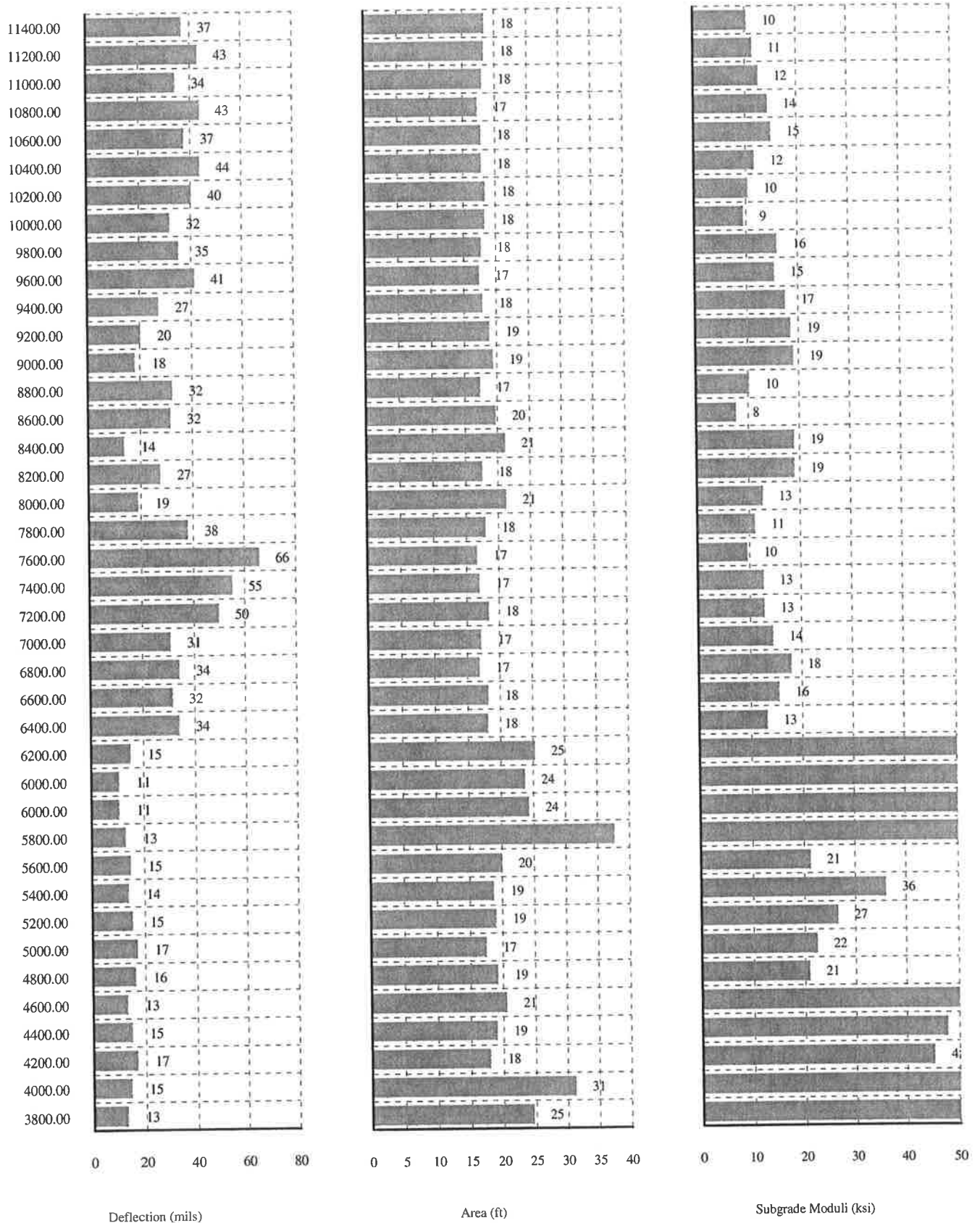
# FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 3600</b>		<b>Temperature = 73.1 deg F</b>					
Drop 1	16026.0	31.61	24.13	18.78	8.19	3.77	2.22
Drop 2	12083.0	24.91	19.13	14.95	6.43	2.86	1.69
Drop 3	9103.0	19.07	14.54	11.19	4.68	2.00	1.20
Drop 4	5937.0	12.49	9.48	7.19	2.90	1.23	0.71
Normalized	9000.0	18.86	14.38	11.06	4.62	1.97	1.18
<b>Adjusted Deflection = 20.54 mils</b>		<b>Area = 19.1 in</b>		<b>Modulus = 42.900 ksi</b>			
<b>Station = 3400</b>		<b>Temperature = 73.1 deg F</b>					
Drop 1	16048.0	26.48	20.02	15.65	7.17	3.40	2.09
Drop 2	12072.0	20.56	15.56	12.15	5.50	2.58	1.59
Drop 3	9081.0	15.53	11.70	9.15	4.07	1.87	1.19
Drop 4	5992.0	10.17	7.67	5.96	2.56	1.12	0.71
Normalized	9000.0	15.39	11.59	9.07	4.03	1.85	1.18
<b>Adjusted Deflection = 16.77 mils</b>		<b>Area = 19.5 in</b>		<b>Modulus = 43.143 ksi</b>			
<b>Station = 3200</b>		<b>Temperature = 73.2 deg F</b>					
Drop 1	15796.0	17.22	11.46	8.19	2.44	0.52	0.30
Drop 2	11995.0	13.92	9.49	6.90	2.09	0.48	0.30
Drop 3	9048.0	10.97	7.57	5.53	1.69	0.41	0.25
Drop 4	5828.0	7.46	5.23	3.81	1.17	0.29	0.20
Normalized	9000.0	10.92	7.54	5.50	1.68	0.41	0.25
<b>Adjusted Deflection = 11.88 mils</b>		<b>Area = 23.1 in</b>		<b>Modulus = 204.532 ksi</b>			
<b>Station = 3000</b>		<b>Temperature = 74.3 deg F</b>					
Drop 1	15961.0	16.17	11.59	8.58	2.65	0.34	0.00
Drop 2	12214.0	13.20	9.56	7.26	2.27	0.33	0.07
Drop 3	9213.0	10.46	7.65	5.78	1.80	0.31	0.08
Drop 4	5915.0	7.07	5.23	3.98	1.24	0.21	0.06
Normalized	9000.0	10.24	7.49	5.66	1.76	0.30	0.08
<b>Adjusted Deflection = 10.94 mils</b>		<b>Area = 34.3 in</b>		<b>Modulus = 648.145 ksi</b>			
<b>Station = 2800</b>		<b>Temperature = 74.3 deg F</b>					
Drop 1	16136.0	25.13	17.77	12.90	4.90	1.96	1.15
Drop 2	12148.0	19.62	14.04	10.35	3.93	1.61	0.97
Drop 3	9256.0	14.80	10.50	7.77	2.95	1.21	0.77
Drop 4	5937.0	9.63	6.78	4.94	1.85	0.79	0.49
Normalized	9000.0	14.40	10.21	7.55	2.87	1.18	0.75
<b>Adjusted Deflection = 15.38 mils</b>		<b>Area = 19.3 in</b>		<b>Modulus = 67.987 ksi</b>			
<b>Station = 2600</b>		<b>Temperature = 74.5 deg F</b>					
Drop 1	16081.0	19.90	14.91	11.54	5.44	2.77	1.91
Drop 2	12236.0	15.52	11.63	8.94	4.15	2.07	1.44
Drop 3	9235.0	11.67	8.72	6.63	2.96	1.45	1.03
Drop 4	6047.0	7.64	5.72	4.26	1.85	0.81	0.62
Normalized	9000.0	11.37	8.50	6.46	2.88	1.40	1.00
<b>Adjusted Deflection = 12.10 mils</b>		<b>Area = 19.9 in</b>		<b>Modulus = 50.843 ksi</b>			
<b>Station = 2400</b>		<b>Temperature = 74.5 deg F</b>					
Drop 1	16136.0	20.65	14.76	10.80	4.59	2.33	1.73
Drop 2	12280.0	16.28	11.61	8.42	3.53	1.79	1.36
Drop 3	9235.0	12.39	8.86	6.35	2.54	1.27	1.00
Drop 4	6036.0	8.21	5.89	4.17	1.60	0.81	0.61
Normalized	9000.0	12.08	8.64	6.19	2.47	1.24	0.97
<b>Adjusted Deflection = 12.86 mils</b>		<b>Area = 18.4 in</b>		<b>Modulus = 52.337 ksi</b>			

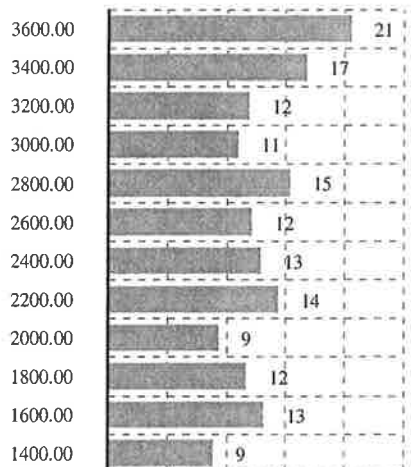
## FWD - Non Destructive Pavement Testing

Drop	Weight (lbf)	@0.00	@8.00	@12.00	@24.00	@36.00	@48.00
<b>Station = 2200</b>		<b>Temperature = 74.6 deg F</b>					
Drop 1	16081.0	24.91	18.79	14.70	6.86	3.17	1.77
Drop 2	12236.0	19.01	14.31	11.15	5.12	2.37	1.37
Drop 3	9213.0	13.87	10.38	8.00	3.55	1.63	1.01
Drop 4	6014.0	8.84	6.57	5.01	2.19	1.00	0.64
Normalized	9000.0	13.54	10.13	7.80	3.46	1.59	0.99
<b>Adjusted Deflection = 14.38 mils</b>		<b>Area = 20.1 in</b>		<b>Modulus = 51.590 ksi</b>			
<b>Station = 2000</b>		<b>Temperature = 74.6 deg F</b>					
Drop 1	15993.0	17.62	13.05	9.88	4.65	2.53	1.65
Drop 2	12302.0	12.52	9.21	6.95	3.33	1.87	1.25
Drop 3	9224.0	8.98	6.56	4.87	2.29	1.30	0.89
Drop 4	6047.0	5.50	4.03	2.96	1.35	0.79	0.55
Normalized	9000.0	8.73	6.38	4.74	2.22	1.26	0.87
<b>Adjusted Deflection = 9.28 mils</b>		<b>Area = 20.3 in</b>		<b>Modulus = 58.726 ksi</b>			
<b>Station = 1800</b>		<b>Temperature = 74.7 deg F</b>					
Drop 1	16081.0	18.47	13.27	10.33	5.27	3.12	2.22
Drop 2	12269.0	14.58	10.46	8.07	4.04	2.37	1.68
Drop 3	9092.0	11.07	7.95	6.12	2.97	1.74	1.24
Drop 4	5926.0	7.34	5.26	4.00	1.93	1.13	0.79
Normalized	9000.0	10.96	7.87	6.06	2.94	1.72	1.23
<b>Adjusted Deflection = 11.63 mils</b>		<b>Area = 19.5 in</b>		<b>Modulus = 41.394 ksi</b>			
<b>Station = 1600</b>		<b>Temperature = 74.7 deg F</b>					
Drop 1	16059.0	23.39	17.77	13.80	6.56	3.24	1.80
Drop 2	12291.0	17.43	13.22	10.30	4.88	2.44	1.43
Drop 3	9202.0	12.69	9.56	7.37	3.43	1.72	1.04
Drop 4	6014.0	7.85	5.91	4.49	2.06	1.04	0.64
Normalized	9000.0	12.38	9.33	7.19	3.34	1.68	1.01
<b>Adjusted Deflection = 13.14 mils</b>		<b>Area = 20.4 in</b>		<b>Modulus = 50.095 ksi</b>			
<b>Station = 1400</b>		<b>Temperature = 73.2 deg F</b>					
Drop 1	16081.0	13.46	9.50	6.97	2.73	1.12	0.62
Drop 2	12324.0	10.71	7.63	5.54	2.26	0.93	0.52
Drop 3	9278.0	8.34	5.98	4.37	1.76	0.72	0.40
Drop 4	5981.0	5.59	4.09	2.97	1.17	0.47	0.26
Normalized	9000.0	8.11	5.82	4.25	1.71	0.70	0.39
<b>Adjusted Deflection = 8.82 mils</b>		<b>Area = 22.5 in</b>		<b>Modulus = 131.256 ksi</b>			

# FWD - Non Destructive Pavement Testing

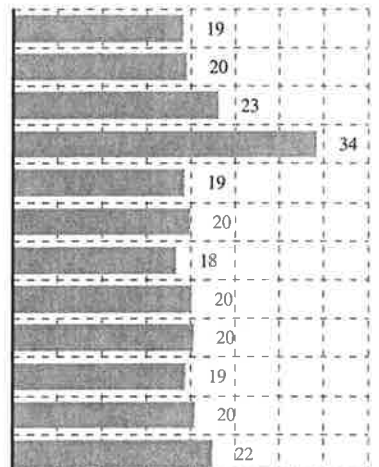


# FWD - Non Destructive Pavement Testing



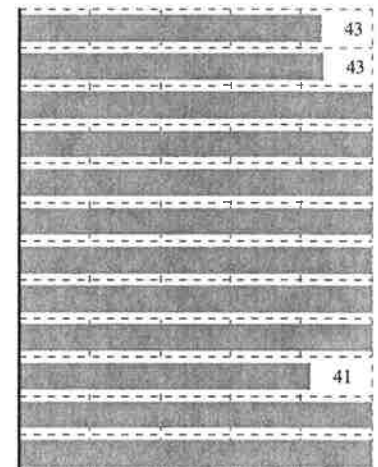
0 5 10 15 20 25

Deflection (mils)



0 5 10 15 20 25 30 35 40

Area (ft)



0 10 20 30 40 50

Subgrade Moduli (ksi)

# **APPENDIX D**

## **SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration Technical Support Document**

### **Final HMA Mix Design**

### **RAS Preliminary Acceptance Test Results**

**Washington State Department of Transportation - Materials Laboratory**  
**PO Box 47365 Olympia / 1655 2nd Ave. Tumwater / WA 98504**  
**BITUMINOUS SECTION MIX DESIGN VERIFICATION REPORT**

HMA CLASS:	1/2"	WORK ORDER NO:	JM1017
DATE SAMPLED:		LAB ID NO:	00000104df5
DATE REC'D:	8/6/2009	TRANSMITTAL NO:	104df5
SR NO:		MIX ID NO:	MD090088
SECTION:	416TH STREET OVERLAY SHINGLES IN PAVING	CONTRACTOR:	WOODWORTH

**VALID FOR 2009**  
~~CONTRACTOR'S MIX DESIGN TEST DATA~~

Pb	5.4		Specifications
% Gmm @ Nini: 8	86.7	≤	89.0
% Va @ Ndes: 100	3.9	Approximate	4.0
% VMA @ Ndes: 100	14.5	≥	14.0
% VFA @ Ndes: 100	73		65 - 75
% Gmm @ Nmax: 160		≤	98.0
D/A	1.5		0.6 - 1.6
Pbe	4.6		
Gmm	2.478		
Gmb	2.382		
Gb	1.028		
Gse	2.712		

~~STATE MATERIALS LABORATORY VERIFICATION TEST DATA~~

Pb	4.0	4.4	5.0		Specifications	Tolerance
% Gmm @ Nini: 8	85.9	86.8	87.8	≤	89.0	±0.5%
% Va @ Ndes: 100	5.2	3.7	2.3	Approximate	4.0	2.5 - 5.5
% VMA @ Ndes: 100	14.6	14.3	14.1	≥	14.0	≥12.5
% VFA @ Ndes: 100	65	74	84		65 - 75	
% Gmm @ Nmax: 160		97.6		≤	98.0	
D/A	1.5	1.4	1.2		0.6 - 1.6	
Pbe	4.1	4.5	5.1			
Gmm	2.478	2.463	2.444			
Gmb	2.350	2.374	2.389			
Gb	1.028	1.028	1.028			
Gse	2.633	2.632	2.635			

~~VERIFIED~~  
~~STRIPPING EVALUATION~~

% Anti-Strip:	0.0%	0.25%	0.50%	0.75%	1.0%
Visual Appearance:	NONE	NONE	NONE	NONE	NONE
% Retained Strength:	94	92	89	97	106

~~STATE MATERIALS LABORATORY RECOMMENDATIONS~~

Asphalt Binder Supplier	U.S. OIL	Remarks:
Asphalt Binder Grade	PG64-22	Verification of Volumetric Properties
Percent Binder (Pb) (By Wt. Total Mix)	4.3	determined by SGC internal angle.
% Anti-Strip (By Wt. Asphalt Binder)	0.00%	Percent binder equates to 4.3% new asphalt,
Type of Anti-Strip		0.6% asphalt from RAP and 0.7% asphalt from
Mix ID Number	MD090088	RAS.
Sample Wt. (grams)	4700	(Informational Only)
Sample Height @ Ndes	115.0	(Informational Only)
Ignition Calibration Factor	0.76	(Informational Only)
Optimum Mixing Temperature	313°F	
Compaction Temperature	291°F	
Rice Density (lbs/ft³)	153.3	

**Washington State Department of Transportation - Materials Laboratory**  
**PO Box 47365 Olympia / 1655 2nd Ave. Tumwater / WA 98504**  
**BITUMINOUS SECTION MIX DESIGN VERIFICATION REPORT**

TEST OF: AGGREGATE PROPERTIES FOR HMA CLASS: 1/2"

WORK ORDER NO: JM1017

LAB ID NO: 00000104df5

MIX ID NO: MD090088

-----CONTRACTOR'S DESIGN AGGREGATE STRUCTURE AND AGGREGATE TEST DATA-----

	Combined	Specifications	Tolerance
Material:	3/4"-#4	1/2"-0	RAP RAS
Source:	B-333	B-333	B-160 B-160
Ratio:	18%	64%	15% 3%
1 1/2" square			
1" square			
3/4" square	100.0	100.0	100.0 100.0
1/2" square	67.8	100.0	96.8 99.6
3/8" square	28.5	97.4	89.8 95.4
U.S. No. 4	3.6	69.6	64.9 78.0
U.S. No. 8	2.5	46.0	48.3 66.6
U.S. No. 16	1.9	31.0	36.7 36.1
U.S. No. 30	1.6	21.6	27.5 11.4
U.S. No. 50	1.5	14.9	18.5 3.6
U.S. No. 100	1.4	9.6	12.5 1.5
U.S. No. 200	1.2	7.4	8.8 1.1

Gsb Coarse	2.697	2.651	
Gsb Fine		2.594	
Gsb Blend	2.697	2.611	2.630
Sand Equivalent		63	63 45 MIN.
Uncompacted Voids (FAA)			46 44% MIN.
Coarse Agg Frac			
U.S. No. 4	95	99	97 ≥ 90% Double Face Fracture

-----STATE MATERIALS LABORATORY AGGREGATE TEST DATA-----

Gsb Coarse	2.684	2.697	
Gsb Fine		2.599	2.599
Gsb Blend	2.684	2.628	2.640
Sand Equivalent		80	80 45 MIN.
Uncompacted Voids (FAA)			46 44% MIN.
Coarse Agg Frac			
U.S. No. 4	97	98	98 ≥ 90% Double Face Fracture

-----COMMENTS-----

Remarks:

Verification of Volumetric Properties determined by SGC internal angle.

Environmental & Engineering Programs:	T152 -	THOMAS E. BAKER P.E.
Construction Engineer-----	X T153 -	Materials Engineer
Accounting Section-----	X T166 - 2	By: Joseph R. DeVol <i>SED</i>
General File-----	X T172 -	Bituminous Materials Engineer
Bituminous Materials Section-----	X T175 -	(360) 709-5421
Region: NORTHWEST	T178- 1	Date: 9 / 18 / 2009
Construction Office--43 -----	X	
Materials Engineer--43 -----	X	
P.E.: KING COUNTY	X(2)	

155 Monroe Ave. NE, Bldg D  
Renton, WA 98056-4199  
Phone: 206.296.7709  
Fax: 206.296.0179

## Aggregate Test Data

Project:	<b><i>SE 416th Street Overlay, Shingles in Paving Demonstration</i></b>
Type of Material:	<b><i>Recycle Asphalt Shingles, RAS</i></b>
Purpose of Sample:	<b><i>Acceptance</i></b>
Sampled At:	<b><i>Plant Stockpile</i></b>
Name and Location of Source:	<b><i>Woodworth &amp; Co.</i></b>

Project Number: M78030  
Lab Sample Number: KC-09-1122  
Date Sampled: 9/10/09  
Sampled By: K Beatty  
Pit #: \_\_\_\_\_

Total Weight: <b>764.6 g</b>				
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
5/8"	0.0		100	
1/2"	6.9	100	99	
3/8"	45.4	95 min.	94	
1/4"	156.0		80	
#4	210.5		72	

**Fract. Wt. Avg. + #4:**

Fracture Spec:

Dust Ratio:

Dust Ratio Spec:

**Sand Equivalent(AASHTO T176):**

SE Spec:

Material        meets specifications.  
 ✓ does not meet

Reviewed By:

Approved for

Distribution By:

## Materials Engineer

Inspector Remarks: Does not meet design specification for gradation or moisture content but meets engineer 109 intent and is acceptable. V

Subsample Weight:		<i>g</i>		
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
<b>#200 Wash (AASHTO T11A):</b>				
Mass Before:		<i>g</i>		
Mass After:		<i>g</i>		
#200		<i>max.</i>		

Remarks: Ref: (AASHTO T2, T11(A), T27, T176, T248, TP61)

Moisture Content = 10.0%, max. 5.0%

**Lighter Extraneous Material = 0.06%, max. 1.5%**

**Total Extraneous Material = 0.06%, max.3.0%**

**Ref.: Contract Special Provisions 9-36.2**

Date: 9/16/09 Tested By: RV

**Distribution:**

Date(s):	To:	# Copies	
		1	Resident Engineer
			Project Engineer
		1	Const. Admin.
			Contractor
		1	Pit Log
		1	Mat Lab File
			Fax
			Fax



155 Monroe Ave. NE, Bldg D  
Renton, WA 98056-4199  
Phone: 206.296.7709  
Fax: 206.296.0179

## Aggregate Test Data

Project:	<i><b>SE 416th Street Overlay, Shingles in Paving Demonstration</b></i>
Type of Material:	<i><b>Recycle Asphalt Shingles, RAS</b></i>
Purpose of Sample:	<i><b>Acceptance</b></i>
Sampled At:	<i><b>Plant Stockpile</b></i>
Name and Location of Source:	<i><b>Woodworth &amp; Co.</b></i>

Project Number: M78030  
 Lab Sample Number: KC-09-1123  
 Date Sampled: 9/10/09  
 Sampled By: K Beatty  
 Pit #: \_\_\_\_\_

Total Weight: 1028.2 g				
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
1"	0.0		100	
3/4"	2.1		100	
5/8"	3.9		100	
1/2"	17.1	100	98	
3/8"	77.3	95 min.	92	
1/4"	207.8		80	
#4	276.5		73	

**Fract. Wt. Avg. + #4:**

Fracture Spec:

**Dust Ratio:**

Dust Ratio Spec:

**Sand Equivalent(AASHTO T176):**

SE Spec:

**Material** \_\_\_\_\_meets specifications.  
                 ✓  
                 does not meet

Reviewed By:

Approved for

Distribution By:

## Materials Engineer

Inspector Remarks: Does not meet design specification for gradation or moisture content but meets engineering intent and is acceptable.

Subsample Weight:		<i>g</i>		
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
<b>#200 Wash (AASHTO T11A):</b>				
Mass Before:		<i>g</i>		
Mass After:		<i>g</i>		
#200		<i>max.</i>		

Remarks: Ref: (AASHTO T2, T11(A), T27, T176, T248, TP61)

**Moisture Content**(= 9.3%, max. 0.5%)

**Lighter Extraneous Material = 0.01%, max. 1.5%**

**Total Extraneous Material = 0.01%, max. 3.0%**

**Ref.: Contract Special Provisions 9-36.2**

Date: 9/16/08 Tested By: [Signature]

**Distribution:**

Date(s):	To:	# Copies	
		1	Resident Engineer
			Project Engineer
		1	Const. Admin.
			Contractor
		1	Pit Log
		1	Mat Lab File
			Fax
			Fax

155 Monroe Ave. NE, Bldg D  
Renton, WA 98056-4199  
Phone: 206.296.7709  
Fax: 206.296.0179

### Aggregate Test Data

Project:	<b><i>SE 416th Street Overlay, Shingles in Paving Demonstration</i></b>
Type of Material:	<b><i>Recycle Asphalt Shingles, RAS</i></b>
Purpose of Sample:	<b><i>Acceptance</i></b>
Sampled At:	<b><i>Plant Stockpile</i></b>
Name and Location of Source:	<b><i>Woodworth &amp; Co.</i></b>

Project Number: M78030  
 Lab Sample Number: KC-09-1124  
 Date Sampled: 9/10/09  
 Sampled By: K Beatty  
 Pit #: \_\_\_\_\_

Total Weight: <b>676.5 g</b>				
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
<b>1"</b>	<b>0.0</b>		<b>100</b>	
<b>3/4"</b>	<b>2.0</b>		<b>100</b>	
<b>5/8"</b>	<b>3.9</b>		<b>99</b>	
<b>1/2"</b>	<b>16.5</b>	<b>100</b>	<b>98</b>	
<b>3/8"</b>	<b>49.7</b>	<b>95 min.</b>	<b>93</b>	
<b>1/4"</b>	<b>122.2</b>		<b>82</b>	
<b>#4</b>	<b>163.0</b>		<b>76</b>	

Fract. Wt. Avg. + #4: \_\_\_\_\_  
Fracture Spec: \_\_\_\_\_

**Dust Ratio:** \_\_\_\_\_  
**Dust Ratio Spec:** \_\_\_\_\_

Sand Equivalent(AASHTO T176): \_\_\_\_\_  
SE Spec: \_\_\_\_\_

Material            meets specifications.  
           ✓ does not meet

Reviewed By: \_\_\_\_\_  
Approved for \_\_\_\_\_  
Distribution By: \_\_\_\_\_  
Materials Engineer

Inspector Remarks: Does not meet design specifications for gradation or moisture but meets requirements for placement and is acceptable.

Subsample Weight:		<i>g</i>		
Sieve	Retained Weight	Required Spec.	Percent Passing	Percent Fractured
<b>#200 Wash (AASHTO T11A):</b>				
Mass Before:		<i>g</i>		
Mass After:		<i>g</i>		
#200		<i>max.</i>		

Remarks: Ref: (AASHTO T2, T11(A), T27, T176, T248, TP61)

Moisture Content = 10.8%, max. 5.0%

**Lighter Extraneous Material = 0.03%, max. 1.5%**

**Total Extraneous Material = 0.03%, max.3.0%**

**Ref.: Contract Special Provisions 9-36.2**

Date: 9/16/09 Tested By: [Signature]

**Distribution:**

Date(s):	To:	# Copies	
		1	Resident Engineer
			Project Engineer
		1	Const. Admin.
			Contractor
		1	Pit Log
		1	Mat Lab File
			Fax
			Fax

# **APPENDIX E**

## **SE 416<sup>th</sup> Street Overlay: Shingles in Paving Demonstration Technical Support Document**

### **Construction Inspection and Quality Control**

**SE 416<sup>th</sup> Street Overlay:  
Shingles in Paving Demonstration**

**Construction Inspection and Quality Control Testing**

**Road Preparation (9-21-09)**

**Inspectors Daily Report**

KING COUNTY DEPARTMENT OF TRANSPORTATION  
CONSTRUCTION SERVICES SECTION  
**INSPECTORS DAILY REPORT Page 1 of 2**

DATE: Monday September 21st 2009

Federal Aid # \_\_\_\_\_

PROJECT NO. **M78030**

CONTRACT NO. **C00455C09**

PROJECT: \_\_\_\_\_

**SE 416th ST Overlay- Shingles in Paving  
Demonstration**

INSPECTOR (S): \_\_\_\_\_

**S.Shandil, M.Pavolka**

CONTRACTOR: \_\_\_\_\_

**Woodworth & Company**

WEATHER: \_\_\_\_\_

Clear

TEMP: High 80 Low 60

WIND: Still X Moderate X High \_\_\_\_\_

Workable 8 Nonworkable 0

SIGNS AND TRAFFIC CONTROL CHECKED? Yes X No \_\_\_\_\_

ON-SITE INTERVIEW? Yes \_\_\_\_\_ No X

**WORK DONE:**

- **Woodworth (Paving):** 7am Set up traffic control signs and flaggers on 244th ave and various cross streets on SE 416th st. Dave, Luke and Andy help with Grinding crew with Penny on b/hoe removing traffic buttons. Use compressor to remove remaining grinds at water valves and to straight joints. Place paper joints at each end of project. End work at 3pm. Flaggers cont. to place detour signs for paving operation.
- **Gloria Jeanne: (Grinding):** Mob in equipment at 6.20am. Begin grinding at 7.30am from 244th Ave to 212th ave with Kyle operating grinder with Jerry and Edwards as spotters. Using pick up sweeper to remove grinds and two solo trucks to haul grindings. Grinded butt joints at 244th/Se 416th, side street butt joints at 228th and 236th ave, 212th/ Se 416th, entire bridge and trench Xing.

**EQUIPMENT ON PROJECT:**

- **Woodworth:** 1 - Flagging truck( Chevy 2500 HD # 1264), 1- F/M work truck(F 450 super duty #62), 1 Back Hoe( JD 510D), 2- solo dump trucks, I.R 185 Compressor(# 614)
- **Gloria Jeanne:** CAT PM201 Grinder, 1- Peter Bilt water truck, 1- ELGIN pick up sweeper, Peter Bilt truck plus Load King Trailer.

**PERSONNEL ON PROJECT:**

- **Woodworth:** 1- Project Manager( Scott Droppellman), 1- F/M ( Dave Thornton), 2- operators( Penny Cochran, Luke Dillard), 1- Labor ( Andy Smith), 1- TCS ( Tara), 4- Flaggers( Glen, Katy, Ray and Paula), 2- Dump truck drivers.
- **Gloria Jeanne:** 1- F/M (Kyle Manger), 2 - spotters (Jerry Anne and Edward Phirler), 1- pick up sweeper operator (Kelly).
- **King County:** Paul Moore, Kevin, Alan Corwin(Lab)
- **Others:** Warren (Enumclaw water district)

**REMARKS:**

- Marked section for each day of paving. They are about 2670' apart but can change during actual paving. Showed section that needs pre-leveling to Scott.
- Called K.C Maintenance for round C.B Riser at 244th and SE 416TH. C.B was buried and got exposed during grinding operation. Talk to Tom. They will get a round riser on 09/22. If nothing available then we will place paper over it and cover it with HMA.
- Notified Enumclaw Water district (Warren) about paving on 09/22/09. Gave him Scott's phone # so as to discuss how Woodworth wants the water risers done.
- Maintenance to remove over grown black berry along road edge at creek crossing.
- Grinded entire bridge crossing removing 1" of existing asphalt and 20' each side of bridge.
- Butt joints on 244th and 212th ave were at stations 115+95(2") to 116+27(0") and 10+17(2") to 10+46(0") entire width. Side street joints at 228th and 236th were on both side at 7' wide, grinding entire Bridge width from 78+90 (0") to 79+10(1"), 79+10 to 79+53 at 1" and 79+53 (1") to 79+95(0"), trench crossing at 21+31 to 21+41 entire width.

INSPECTOR(S) TIME: \_\_\_\_\_

White - Contract File  
Yellow - Project Engineer  
Pink - Inspector's Diary

INSPECTOR'S SIGNATURE: \_\_\_\_\_